SCIENTIFIC AMERICAN

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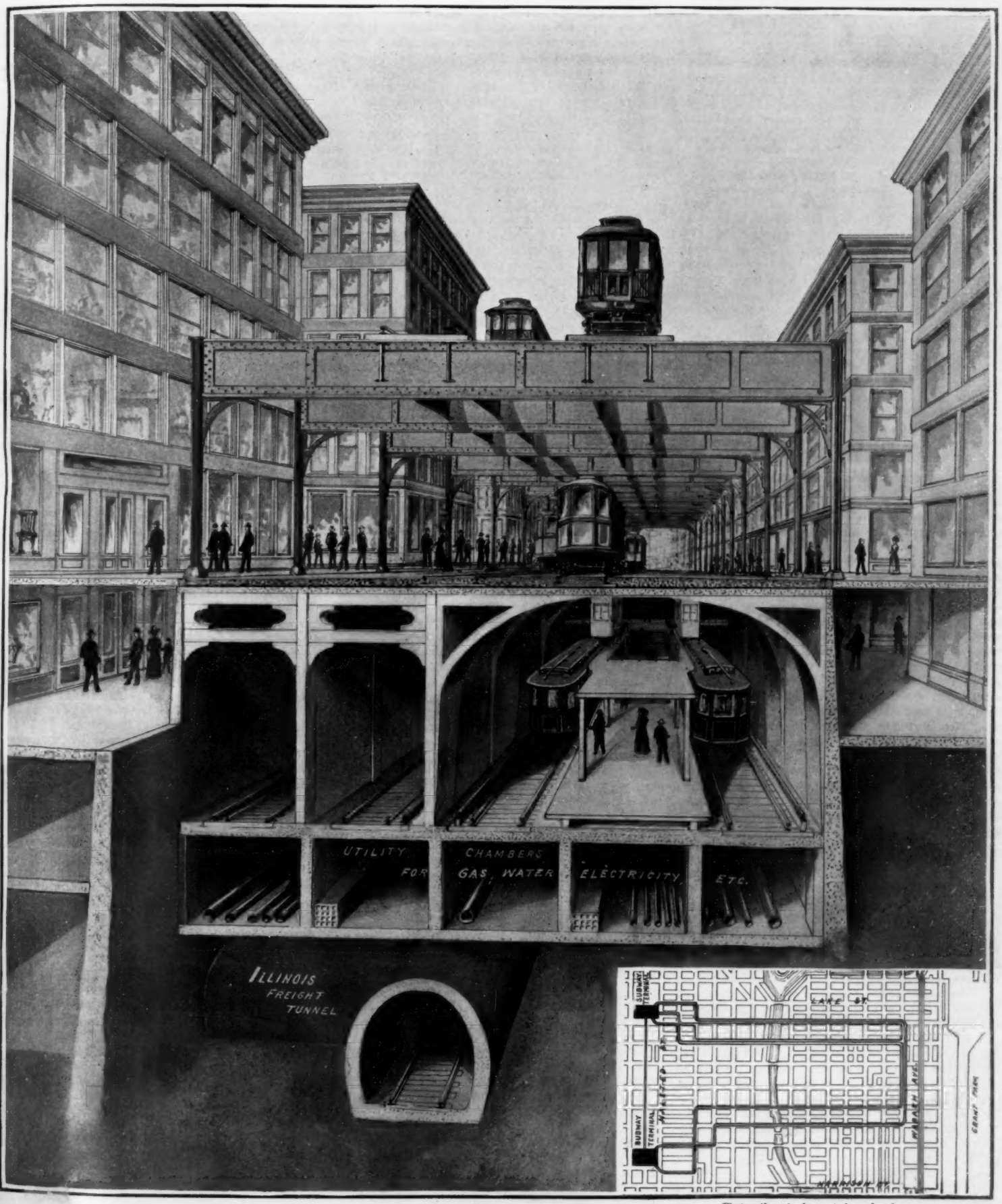

First section of subways to be undertaken.

Chicago proposes gradually to place all tracks, surface and elevated, that enter the business zone, below street level. The above view shows a station on the new Wabash Avenue four-track subway. The trolley cars are to the right, the elevated express cars use the left-hand track. The lowest tunnel is the present 60-mile freight subway.

HOW CHICAGO IS SOLVING ITS RAPID TRANSIT PROBLEM.—[See page 439.]

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NEW YORK, SATURDAY, MAY 28th, 1910.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

OUR NATIONAL GOOD ROADS LABORATORY.

AMONG the less known, but by no means less important, sections of the broad field of activity covered by the Department of Agriculture, is that which comes under the Office of Public Roads. Although this office has no administrative duties, and exercises no control over the roads of the United States—except, of course, those that are located on government reservations—it is doing most important work of a scientific and educational character.

The movement for Federal assistance in the promotion of good roads dates back to the year 1893, when a modest appropriation of $10,000 was made, to enable the Secretary of Agriculture to inaugurate the work. To date, a sum of nearly half a million dollars has been appropriated; and if this year's estimate be included, the total reaches about six hundred thousand dollars.

A full account of the growth of this movement is presented on another page of this issue; and it gives us much pleasure to draw particular attention to that branch of the Office of Public Roads which is known as the Division of Tests. We make this special reference on account of the high character of its organization and work, and because one of our recent editorials would give the impression that no such division exists. As a matter of fact, this laboratory, as we are informed by Director A. W. Page, is not only equipped with the best and most improved apparatus used in European laboratories, but has developed a number of additional tests, such as those for toughness and cementing value. Routine tests are made on road-building materials, free of charge, for any citizen of the United States, and a large amount of experimental and research work is being carried on. Indeed, it is justifiable to state that the laboratory of the Office of Public Roads is the most completely equipped road material laboratory in the world, and that the number of samples tested yearly is far greater than in any similar institution. As a matter of fact, during the present year, about three hundred typical samples of the road-building rocks of England, Scotland, and Wales were tested, by special request, in addition to the regular routine work.

ARBITRATION VERSUS SELF-REDRESS.

AS surely as the duel has given place, among individuals, to the court of justice, will the awful arbitrament of war give way to the international tribunal; also, as a corollary to this, it may be written down that as the court of justice has back of it for the enforcement of its decrees the punitive machinery of the government, so will the international court be backed by some form of international police, composed of limited naval and military forces, in which each of the signatories to the international court will be represented.

One of the brightest auguries of the dawn of a world-wide peace is to be found in the fact that it has become the fashion, during the past year or two, to speak of armies and navies as means for the preservation of peace. When the leaders of the world, be they presidents, kings, or emperors, declare that every increase in the armed strength of their respective countries is undertaken for the express purpose of preserving peace, the statement is generally accepted as sincere. Although the advocates of peace by arbitration deplore the enormous investment of treasure, time, and labor involved in the maintenance of the vast military organizations of the civilized world, they are beginning to believe that the advocates of peace by war are as anxious as they themselves that the world's peace be permanently preserved.

The establishment of the noble principle of international arbitration will be, after all, merely a repetition in the international world of a process of evolution from barbarism to civilization, which has long ago taken place in the individual national world. Far back in the beginnings of human history, the principle of self-redress was paramount. If wrong or fancied wrong was done, the injured party encompassed the death of his enemy by such ready means as might be at hand. Gradually, with the growth of intelligence, it was realized, not only that the injured party was but a poor judge of his own cause, but that the principle of self-redress was subversive of the peace and happiness of the community. It was realized, also, that the man whose brain was clouded with the smoke of furious passion, was not so well qualified a judge as some third and disinterested party, who could look upon the case in dispute with an impartial eye; and so, gradually but surely, the principle of arbitration took shape and became the stable rock on which our wonderful modern system of national jurisprudence has been erected.

We have before us a lucid review of the growth of the principle of national arbitration in a pamphlet published by the Maryland Peace Society and written by James Brown Scott, lecturer on international law in the George Washington and Johns Hopkins universities. He refers to the three stages which were shown in the development of the celebrated Roman judicial system, which were as follows: (1) The private litigant submitted his controversy to an arbiter of his own choice for decision according to the conscience of a good and impartial man; (2) the magistrate or judge chosen from an official list or panel is preferred to a citizen arbitrator; (3) the administration of justice is regarded as the duty and therefore the right of the State, and a judicial system is prepared for and imposed upon the citizen.

The author of the paper sees the same unconscious development taking place in the gradual growth of arbitration between states. In early times they would choose as arbiter the Pope; in modern times, some foreign sovereign. The lack of continuity of decision in this system, which dealt with the individual case, led up to the second stage, dating from the first conference, which involved the appointment by international action of a panel of judges, from which judges forming the temporary tribunal are chosen. "We stand," says the writer, "upon the very threshold of the third and final development, when nations as a whole determine that international justice is the province of the international community, and constitute a court of international justice, to which litigant states may resort in conflicts of importance." To-day, much has been done. The organization, jurisdiction, and procedure of this international tribunal have been determined. Now, we merely await the appointment of judges to establish a world-wide court, in which the nations may obtain justice as easily and readily as private suitors in national courts of justice.

The author of this paper does not go into the question of the enforcement of the findings of international arbitration. It is our belief that an international court should be backed by an army, composed of drafts from the various armies of the world previous to their disarmament, limited in numbers, and existing solely for the enforcement of its decrees.

SIR WILLIAM HUGGINS AND HIS WORK.

WITH the death of Sir William Huggins, there passed away an astronomer whose pioneer work in the field of astro-physics has earned for him an enduring place in the history of science. It was largely due to Sir William's genius that the spectroscope became an instrument of astronomical investigation hardly less important than the telescope. His work was done so many years ago, and its results have been so far-reaching, that it is easy enough to value it at its true worth.

Huggins began his studies shortly after Kirchoff applied the terrestrial science of spectrum analysis to the study of the sun. Partly as a result of Huggins's efforts astronomers have been enable to observe the solar prominences at any time, without waiting for an eclipse; for the principle of spectroscopic visibility of prominence lines at the edge of an uneclipsed sun was quite explicitly stated by him in February, 1868. He even devised various instruments for bringing the prominences into actual view. His use of the "open slit" on February 13th, 1869, may be said to have begun the modern study of solar prominences. Before the days of the "open slit," prominences had been examined only in sections.

The first tangible results in the estimation of movements of approach and recession between the earth and the stars, by means of Doppler's principle, were communicated by Sir William Huggins to the Royal Society on April 23rd, 1868. Application of this method to the stars is encompassed with difficulties; for it needs a powerful dispersive spectroscope to show a minute line of displacement, and powerful dispersion involves a strictly proportionate enfeeblement of light. Selecting the brightest star in the heavens as the most promising subject of experiment, Huggins considered the F line in the spectrum of Sirius to be just so much displaced toward the red as to indicate recession at the rate of 29 miles a second. The inquiry was resumed by Huggins with improved apparatus in the following year, when the velocities of thirty stars were approximately determined. The scope of Sir William Huggins's achievement was not, however, to detect the motion in the line of sight so much as to establish the method of procuring data. His success has been of incalculable value, so much so, that the spectroscopic investigations of stellar movements may confidently be expected to play a leading part in the unraveling of the vast and complex relations which even now we dimly detect among the stars.

The first successful application of the spectroscope to comets was made by Donati in 1864. Comets had previously been considered to shine mainly, if not wholly, by reflected sunlight. They were now perceived to be self-luminous and to be formed, to a large extent, of glowing gas. The next step was to determine the nature of this gas, a problem first attacked by Sir William Huggins in 1868. Winnecke's comet (comet II, 1868) was the subject of his experiment. He first revealed the typical hydro-carbon spectrum with which we are now familiar. Tebbutt's comet (comet III, 1881) was the first comet of which the spectrum was photographically recorded, a feat in which Huggins was completely successful. That achievement threw open to investigation a part of the cometary spectrum invisible to the eye, so as to afford an additional test of cometary constitution.

In the field of stellar spectroscopy, Huggins's work is assuredly monumental. Almost simultaneously in 1862, this novel line of investigation was entered upon by Huggins in London, by Father Secchi in Rome, and by Lewis M. Rutherfurd in New York. Hence Huggins may well be considered as one of the fathers of stellar spectroscopy. When he brought to a successful culmination his early experiments in spectroscopic photography, we really began to learn something of the composition of the fixed stars. On December 18th, 1879, he was able to communicate to the Royal Society results answering to his expectations.

The dry-plate process, with which such wonderful results have been obtained in astronomical photography, appears to have been first made available by Sir William Huggins in photographing the spectrum of Vega in 1866. That work laid the foundation for the brilliant application of photography to astronomy by Common, Draper, Jannsen, Rutherfurd, and later astronomers.

A fairly complete preliminary answer to the question, "What are the stars made of?" was given by Sir William Huggins in 1864. By laboriously comparing stellar dark lines and the bright rays emitted by terrestrial substances, he sought to verify his conclusions, regardless of cost in time and trouble. Although he himself averred that the full investigation of a single star spectrum would be the work of years, he was able to furnish, however, detailed and accurate drawings of the spectra of Betelgeux and Aldebaran.

Before Huggins applied the spectroscope to the study of nebulæ, it was felt that these mysterious, filmy objects of light would forever thwart the astronomer. Each new and more powerful telescope that made its appearance had resolved into clusters stars which previously had appeared to the naked eye as single orbs. It was felt that those filmy stars which had resisted all attempts at telescopic resolution might be similar clusters, for which reason some doubt was cast upon Herschel's theory that they were masses of "shining fluid."

On August 29th, 1864, Sir William Huggins sifted through his prisms the rays of a bright planetary nebulæ in Draco. To his infinite surprise, they proved to be of one color mainly and thereby proclaimed their gaseous nature. Thus Herschel's conjecture of a "shining fluid" diffused at large throughout the cosmos was unexpectedly verified. By 1868 Huggins had separately examined the spectra of about seventy nebulæ, of which one-third displayed gaseous characteristics. All of these gave the green ray fundamental to the nebular spectrum and emanating from an unknown form of matter named by Huggins "nebulum." A successful beginning in nebular spectrography was made by Sir William Huggins on March 7th, 1882. Five lines in all stamped themselves upon a plate, exposed to the rays of the nebula in Orion. Thus was photgraphy definitely made the scribe of the nebulæ.

The effect of Huggins's work has been to remove the astronomer from the eye-piece of the telescope, to substitute for the retina the more sensitive photographic plate, and to teach the astronomer the immeasurable value of the spectroscope in analyzing the composition of stars which in the telescope appear as mere points of light pricked in a sable canopy. Huggins introduced physical methods into astronomy and transformed the observatory into a laboratory.

AERONAUTICS.

On May 19th M. Scheurt flew from Mourmelon to Chalons, France, a distance of about 30 miles across country. The flight was made in a biplane at a claimed speed of 46½ miles an hour.

Daniel Kinet, a Belgian, flew 2 hours and 51 minutes with a passenger in France on the 15th instant. This flight was also made in a biplane and constitutes a new world's record.

Mr. Clifford B. Harmon has been making some excellent flights of nearly a half hour's duration at Mineola, L. I., in the Farman biplane which he purchased from Paulhan. On the 21st he gained the pilot-aviator license of the Aero Club of America by making a 3-mile flight. He is the first amateur sportsman in America to take up aviation, and is doing a great deal for the cause.

Mr. Moore, of Washington, D. C., who has been Mr. Emile Berliner's assistant for some time past, has constructed a very light monoplane, fitted with a 35-horsepower revolving-cylinder motor. The machine and motor complete weigh but 260 pounds. The motor is placed above and between the wings at the front end of the machine. The cylinders revolve in a horizontal plane, and drive the propeller through bevel gears. Mr. Moore has gotten off the ground a number of times with his monoplane and made several successful short flights.

On May 18th, the day when the tail of Halley's comet was expected to sweep over the earth, Prof. A. Lawrence Rotch sent up a series of sounding balloons from his Blue Hill Observatory. These balloons were equipped with meteorographs and with apparatus for obtaining samples of the air at high altitudes. Prof. Rotch's observations were made simultaneously with those of thirty other experiment stations scattered throughout Europe. Some members of the U. S. Geological Survey also attempted to catch particles of cometary dust at the Carnegie Observatory on Mount Wilson, California, by placing on a high tower a plate coated with glycerine. Several balloon parties were organized throughout the country to view the comet when it was nearest to us.

Another new monoplane that has flown successfully is that of Mr. Gardner Hubbard, which was built by Messrs. McCurdy and Baldwin at Baddeck, Canada. This machine is a cross between the Blériot and Antionette types. It has 260 square feet of supporting surface, the overall length being 34 feet and the spread of the wings 30 feet 2 inches. It weighs complete about 1,000 pounds without the aviator, a 40-horsepower, six-cylinder water-cooled motor of 320 pounds weight furnishing the motive power. The propeller is driven by sprockets and chain, with a gear reduction of three to five. On April 5th, nine flights were made above the ice on Lake Bras d'Or, by Mr. Hubbard, who had never flown before. The monoplane reached an elevation of about ten feet, and flew several hundred feet each time.

In a recent aeronautic note we mentioned an aeroplane flight of five minutes duration with four passengers. As a matter of fact M. Roger Sommer took but three passengers with him on his record breaking flight of April 20th. These were Mlle. Dutrieux (45 kilogrammes, 99 pounds) and MM. Colombo (60 kilogrammes, 132 pounds) and Frey (58 kilogrammes, 128 pounds). Sommer himself weighs 151 pounds. The total live load was 510 pounds, and the weight of the biplane complete was 550 pounds, making a total weight of 1,060 pounds that the 50-horse-power Gnome motor raised in the air in 20 seconds. The weight-lifting efficiency of Sommer's machine is therefore 92 per cent. The previous record of this kind was made by Henry Farman with a similar machine when he covered 10 kilometers in 10½ minutes with two passengers weighing 110 kilogrammes plus 20 kilogrammes of ballast.

On the 9th instant Messrs. A. H. Forbes and J. C. Yates made an ascension at Quincy Ill., in the former's new balloon "Viking," one of the largest and most up-to-date aerostats thus far constructed. The aeronauts hoped to make new distance and endurance records, but in this they were disappointed. They claim, however, that their balloon reached a height of 20,600 feet nearly 24 hours after they ascended. Because of the great height attained, a considerable amount of gas was lost, and when the balloon descended it was in a flabby condition. As a result of this the concentrating ring settled and pulled the rip cord (which was attached to it), ripping open the balloon when it was 300 feet above ground. It dropped suddenly without any retardation, as the envelope failed to form a parachute. The basket struck the ground squarely and the aeronauts were rendered unconscious. Fortunately they escaped without serious injuries owing to the cushioning effect of a pneumatic mattress which they had in the car.

ELECTRICITY.

By using a stethoscope and a sensitive telephone relay, the heart beats of a patient in London were transmitted to the home of John Milne, the noted seismologist, on the Isle of Wight. The heart throbs were heard by four physicians over an ordinary telephone, and so clear was the transmission that it was possible to diagnose the heart troubles. It is expected that this use of the stethoscope with a telephone relay will enable physicians to keep in better touch with their patients.

An electrical thermometer which is very sensitive to slight fluctuations of temperature, has recently been put out by a German company for medical use, to determine the degrees of fever. It consists of a coil of platinum wire inclosed in a quartz glass tube, through which a current is passed from a four-volt storage battery. The tube is placed in the armpit of the patient, and a milli-voltmeter indicates variations in the resistance of the coil, due to the heat of the body. The milli-voltmeter traces a temperature curve on a band of paper, and in this way it is possible to study the action of drugs on the patient.

According to a recent press report, steamships of the French trans-Atlantic line are using the apparatus invented by Signors Bellini and Tosi of the Italian navy, by which wireless messages may be transmitted in, and received from, any desired direction. The particular advantage of this apparatus on shipboard is the fact that it enables the operator to determine from what direction a signal is coming, and the course of the vessel can be governed accordingly. Recently the "Provence" crossed the Atlantic, equipped with this apparatus, and was able to determine the positions of various vessels passing in the vicinity. The danger of collision was thus entirely obviated.

An interesting paper on insulating materials for wireless telegraphy was read recently before a meeting of the Wireless Institute in this city by Mr. Stanley M. Hills. He pointed out that rubber is not permanent, but apt to deteriorate, that marble is hydroscopic and not to be relied upon because of its irregular composition, that porcelain is apt to contain hidden defects, and that glass, while the defects it contains may be detected visually and thus avoided, is extremely fragile. He spoke of mica and of wood as good insulators if kept dry, and dry oil is a good insulator for the reason that it is liquid and "self-healing." Dry air makes an excellent insulator, and for high voltages, compressed air may be used.

The advantages of an electrical shovel over a steam shovel have recently been portrayed, showing that wherever electricity is available at moderate rates, the electric shovel is much to be preferred. One of the great objections to the steam shovel is the fact that the expenses of a fireman must be paid, and the fuel, as well as the water, have frequently to be carted for a very long distance. Steam must be kept up continuously, despite all delays in operating the shovel, while for the electric shovel the same arguments apply as are made in behalf of electric drive in machine shops, namely, that when the shovel is idle there is no consumption of power, yet the power is ready for instant use whenever it is needed.

An interesting discussion by Dr. Charles P. Steinmetz on the magnetic properties of materials was published in a recent number of the Electrical World. It was stated some years ago that magnetic alloys could be made by combining non-magnetic materials. Dr. Steinmetz points to the fact that in all the Heusler alloys manganese is used, and that this is slightly ferro-magnetic. One of the simplest of these alloys consists in combining one part of manganese with three parts of antimony, the mixture being made by powdering the metals and then heating them in a test tube. The result is a black powder which is strongly magnetic. Dr. Steinmetz states that no magnetic alloy has been found which does not contain some of the ferro-magnetic group—iron, cobalt, nickel, manganese, and chromium.

Now that air craft have been entered as war vessels, inventors are beginning to cast about for some effective means of destroying them. Recently an aerial torpedo has been invented, which, by means of a Hertzian wave controlling system, may be directed from a distance without carrying any operator. This torpedo was exhibited at the London Hippodrome, where the inventor caused it to travel out over the audience, steering it wherever he chose by pressing buttons on a switchboard on the stage. The torpedo is provided with two screws, which may be operated independently to steer the ship laterally, while a horizontal rudder serves to steer the vessel vertically. The device may also be equipped with explosives, to be dropped on the enemy when the torpedo has been maneuvered to the right position. This was demonstrated at the Hippodrome by releasing flowers on the audience.

SCIENCE.

Edward B. Garriott, chief forecaster of the United States Weather Bureau, died recently at Washington at the age of 57. He had been connected with the Weather Bureau practically since its establishment, which means for forty years.

After thirty months' cruising in Philippine waters, the Fish and Game Commission's steamer "Albatross," Commander C. M. McCormick, United States Navy, entered the Golden Gate, San Francisco, and dropped anchor. The "Albatross" has been engaged in a thorough examination of the fish in Philippine waters.

When one solid body glides over the surface of another, the coefficient of friction diminishes as the velocity increases, and nearly vanishes when the velocity attains a certain critical value. This diminution of friction is due to the air which partially separates the two bodies at low relative velocities and separates them completely at the critical and all higher velocities.

Dr. Douglas Mawson, who accompanied Sir Ernest Shackleton on his last Antarctic expedition, arrived recently in this country, bound for Sydney, New South Wales, to resume his duties as lecturer on geology in Sydney University. Dr. Mawson reiterated the statements already made by Sir Ernest Shackleton that there is an immense stream of coal within 300 miles from the South Pole.

An interesting method for measuring the transparency of developed photographic plates has been devised by Dr. L. H. Friedburg. A polarized light apparatus is employed. An opaque plate, not rotating the plane of polarization, when interposed between two parallel mounted tourmaline plates cut parallel to their optical axes, will reduce the angle of 90 deg. between extreme brightness and maximum darkness by an amount proportional to the density of the silver deposit.

The emission spectra produced by certain elements, heated in quartz tubes to 2,500 deg. F., have recently been studied. It is found that in these circumstances sulphur produces a blue light and a nearly continuous spectrum. Selenium gives a pale yellow light with bands, which are generally well defined, but become uncertain toward the red end. Tellurium emits a green light and its spectrum contains numerous bands, which are also hazy toward the red end. Phosphorus and arsenic give a white light and continuous spectra, while antimony produces a nearly continuous spectrum, crossed by very ill-defined bands.

The distinguished German chemist Ostwald has taken out a German patent for the improvement of drawing inks and water colors. He has found that by the addition of small quantities (from 1 : 100 to 1 : 1,000) of volatile organic compounds of the aliphatic series, which are soluble in water, at least to a small extent, and contain not less than four atoms of carbon, inks, drawing inks, and other water colors are rendered capable of readily marking such surfaces as parchment, ivory, waxed paper, etc. In the case of neutral liquids, an alcohol, ester, or other neutral substance is used, while to acid inks, free fatty acids, such as valeric or caproic acid, may be added.

How bright is the sun? No two authorities agree. Another estimate has recently been made by C. Nordmann. The effective temperature determined with his pyrometer was found to be about 5,320 deg. absolute. Now, the brightness of an incandescent body emitting white light varies sensibly as a function of the temperature, and this law has been verified by comparison with numerous terrestrial light sources. Taking into consideration the absorption of the solar atmosphere, the effective temperature of the photosphere is probably about 6,450 deg. absolute. The corresponding brightness of the mean effective layer is then about 319,000 decimal candles per square centimeter. The solar surface is thus considered to behave very like a black body, and to have an emissive power of nearly unity.

Ducelliez has made a study of the chemical character of various alloys of cobalt with tin, antimony, bismuth, lead, and copper, by measuring the difference of potential between each alloy and each of its constituents, when immersed in a solution of cobalt sulphate. The results are expressed in graphical form. The curve of the cobalt-tin alloys shows a distinct inflection at the percentage of 66.76 of tin, which corresponds to the compound CoSn. The cobalt-antimony curve indicates the existence of two definite compounds, CoSb and $CoSb_2$. The cobalt-bismuth alloys also show two distinct compounds. The electromotive force produced by most of these alloys is very small. The curves show that in the separation of the two metals by the process of solution, the cobalt remains undissolved in practically pure condition, while the solution of bismuth contains about 5 per cent of cobalt. The behavior of the cobalt-lead alloys is similar to that of the alloys of cobalt and bismuth.

THE LATEST GIANT FREIGHT ENGINE

FOR USE ON THE HEAVY GRADES OF THE DELAWARE & HUDSON RAILROAD

It takes but a glance at these photographs of the huge Delaware & Hudson freight engine, recently turned out from the shops of the American Locomotive Company, to realize to what Brobdingnagian proportions the freight engine has grown. The two men inside the 41-inch low-pressure cylinders, one of them comfortably seated; the stalwart mechanic, standing erect in the 90-inch front end of the boiler, with a foot-and-a-half clearance between his head and the roof, tell their own story of dimensions. To this may be added the following particulars: There are, as usual in the articulated type, two engines on two trucks; the forward a low-pressure with cylinders 41 inches diameter by 28 inches stroke, the after engine a high-pressure with cylinders 26 inches diameter by 28 inches stroke. Each engine drives eight, coupled, 51-inch driving wheels, which carry the whole weight, 445,000 pounds, of the engine. The tractive power working compound is 105,000 pounds, and the calculated horse-power under ordinary working is over 2,600.

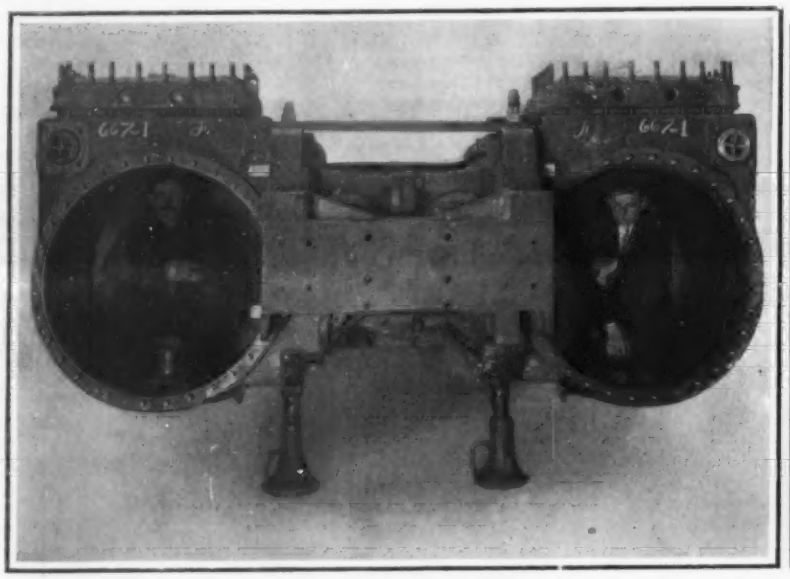
The huge boiler, 90 inches diameter at its smallest ring, has a total heating surface of 6,629 square feet, and it supplies steam at 220 pounds pressure.

The tender carries 9,000 gallons of water and 14 tons of coal; its weight loaded is 166,800 pounds, and the engine and tender together weigh 611,800 pounds.

The engine can haul on the level at 10 miles per hour 100 fifty-ton cars, each of which loaded will weigh 72 tons. This will mean a load behind the tender of 7,200 tons, or a total load for the train of over 7,500 tons.

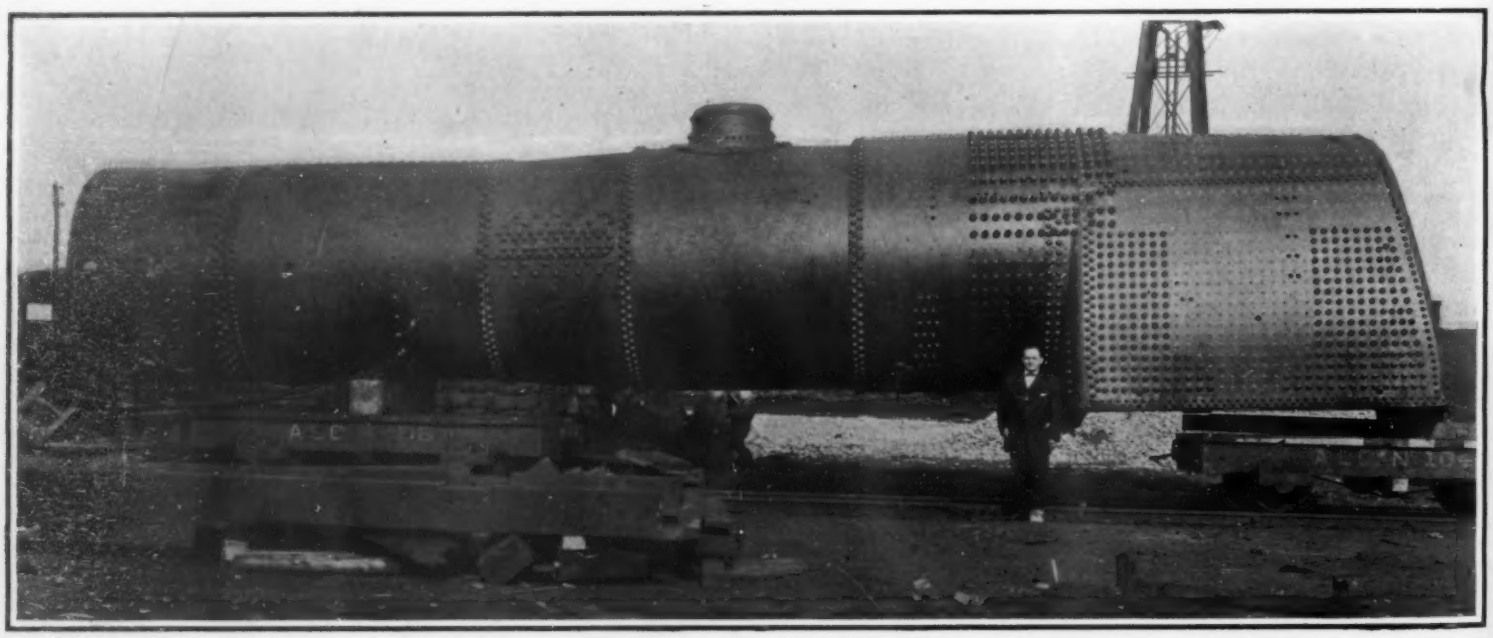
The company has built six of these engines for the Delaware & Hudson Company. They are designed for pusher service on the Wilkesbarre & Susquehanna division of that road, between Carbondale, Pa., and Oneonta, N. Y.—a distance of 95

(*Concluded on page 439.*)



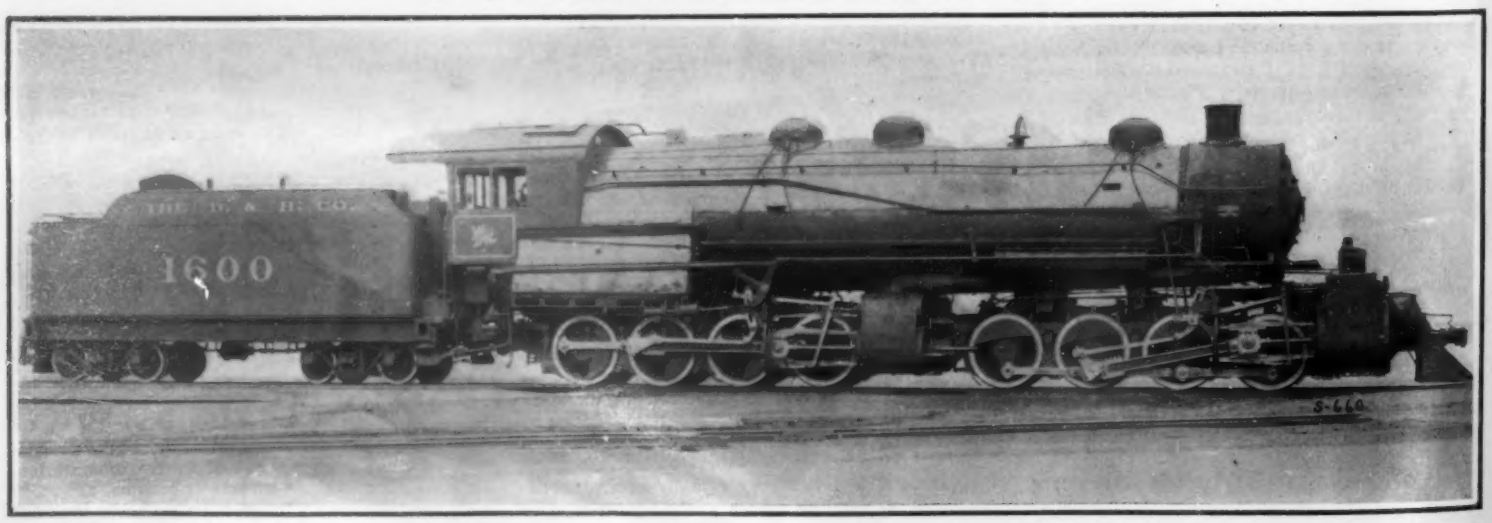
A man can be comfortably seated in each of the 41-inch low-pressure cylinders.

Front end of boiler is 7½ feet diameter.



Largest diameter, 96 inches. **Length,** 44 feet 10 inches. **Weight with water,** 80 tons. **Firebox,** 10 feet 6 inches by 9 feet 8 inches—would make a fair living room.

The huge boiler is the secret of an American locomotive's great power.



Weight, engine and tender, 611,800 pounds. **Weight on drivers,** 445,000 pounds. **Cylinders:** High-pressure, 26 inches by 28 inches; low-pressure, 41 inches by 28 inches. **Tractive power:** Compound, 105,000 pounds; simple, 126,000 pounds. **Boiler pressure,** 220 pounds. **Heating surface,** 6,629 square feet.

THE LATEST OF THE HUGE ARTICULATED FREIGHT ENGINES.

Eiffel's Recent Experiments on the Resistance of the Air

BY JACQUES BOYER

Eiffel's first experiments on the resistance of the air, a problem which is now engaging the attention of many scientists because of its importance in aeronautics, were made in 1907-8 at the famous Eiffel Tower, which was constructed for the Paris Exposition of 1889. The surface on which the pressure of the air was to be studied was allowed to fall from the platform of the second story of the tower, in connection with a chronographic apparatus, which recorded the resistance opposed by the air at each instant. The surface was carried downward by a heavy and dense mass, offering little resistance to the air. This mass was placed above the surface, with which it was connected by springs, which were compressed more or less, according to the air resistance. The velocity of fall ranged from 50 to 130 feet per second. The apparatus was guided in its fall by a vertical cable, and was prevented from striking the ground by a progressive enlargement of this cable beginning at the height of about 70 feet from the ground. In this way the falling body was gradually brought to rest by the action of spring brakes. A tuning fork, making 100 vibrations per second, was attached to the surface. To one of the prongs of this tuning fork was attached a style, which, as the fork vibrated, moved vertically over the surface of a vertical cylinder, which was covered with paper coated with lampblack, and was caused to revolve with a speed proportional to the velocity of fall. Hence the record takes the form of a fine sinusoid, the median line or axis of which forms an irregular line around the cylinder. Each point of this axis corresponds to a certain position of the falling body. The number of undulations between this point and the beginning of the trace, gives the time; the ordinate of the point indicates the tension of the springs, and consequently the pressure of the air on the surface, at that instant; and the abcissa is proportional to the distance through which the body has fallen. Hence the trace gives the position and velocity of the body and the resistance opposed to its motion by the air at every instant. Eiffel experimented in this way with plane surfaces of various forms, square, oblong, circular, continuous, and cut or perforated, with groups of superposed plane surfaces, and even with spherical and conical surfaces. He arrived at the following conclusions: For velocities between 60 and 130 feet per second, the resistance of the air is very approximately proportional to the square of the velocity. The exponent of the velocity differs very slightly from 2 and appears to increase regularly with the velocity, passing through the value 2, at the velocity of 110 feet per second. The pressure per square inch was furthermore found to increase with the area of the surface.

The influence exerted by superposed surfaces on each other is very great. In some cases the resistance is smaller for a group of surfaces than for a single surface. For surfaces inclined to the direction of the wind, Eiffel formulated in 1908 the following law: For inclinations to the horizon varying between 0 and 30 degrees, the pressure is proportional to the angle, while for inclinations greater than 30 degrees, the resistance is constant.

In order to extend these observations (which have been fully described in the SCIENTIFIC AMERICAN) Eiffel constructed in 1909 an aerodynamic laboratory at the Champ de Mars, Paris, where he has subsequently conducted experiments with fixed surfaces, exposed to air currents produced by a blower of 50 kilowatts power. By this method he was able not only to obtain the resultant pressure, but to determine the distribution of pressure on both sides of the surface and the movement of the air in its vicinity.

In order to place the surface in conditions as nearly as possible identical with those produced by a natural wind or by movement in the open air, the air current must have so large a cross section that its exterior filaments will not be affected by the presence of the surface. The pressures experienced by the surface are measured by an aerodynamic balance, by which it is possible to determine the horizontal and vertical components, as well as the center of pressure; data which are very important in the construction of aeroplanes. The aerodynamic balance is shown in diagram in Figs. 1 and 2. The experimental surface is attached to the rod *C*, which is placed parallel to the air current. This rod is attached to a rigid T-shaped frame *DE*, which is capable of motion around a knife edge *A*. The action of the air current is opposed by an upward pull at *f*, produced by the weight *P*, in the balance above. When equilibrium is established the moment of the forces which tend to move the experimental surface and its support round the knife edge *A*, can be computed from the weight in the scale pan. Two weighings are made, when the air is at rest and when it is in motion at known velocity. The moment produced by the air current is the difference of the two results. The other end of the rod *E* carries a second knife edge *B*, which is directed upward and which can be brought to bear against its seat by shortening the rod *H*, by means of the eccentric *G*. In this way the moment of the air pressure around *B* can be measured. Thus it is possible to measure the moments of the pressure with respect to two points; furthermore, as the rod *C* can be rotated about its axis, the elements of the resultant pressure upon an inclined surface can be determined by making four measurements, at azimuths differing by a right angle. The vertical part *D* is a rod of cast steel, which is capable of slight motion in a sheath attached to the floor of the room above, on which the balance stands. This sheath, which is very narrow and is beveled in front and behind, protects the vertical rod from the air current, without appreciably affecting the latter. The horizontal part *E* is provided with a pair of knife edges at each end. The knife edges at the front or windward end *A* are directed downward and backward, while those of the other end *B* are directed upward and backward. The seats of these knife edges have projections, which prevent the knife edges from moving along the grooves in which they turn. By moving a lever, the knife edges in front can be lifted from their seats to protect them from wear, except during the actual experiment. The rod *H*, which connects the frame *E* with the beam of the balance, touches these parts only by means of knife edges. In short, all the moving parts of the apparatus turn on knife edges, and the friction is negligible. The T-shaped piece *DE* weighs more than 100 pounds. This great weight is not an inconvenience, but serves two useful purposes, by lessening and damping the secondary oscillations, due to small variations in the force of the air currents, and by making the equilibrium of the balance stable in every relative position of the current and the surface. The entire apparatus is supported by a massive wooden platform, about 8 feet square, which rests on a double layer of sleepers, buried 10 feet below the floor of the room and lying parallel with the direction of the air current.

The current of air is drawn through a tube 6½ feet in diameter, and every precaution is taken to keep its strength uniform during the experiment. The air is drawn from a large closed room in which the surface

Fig. 9.—The Eiffel aerodynamic balance placed above the experiment room.

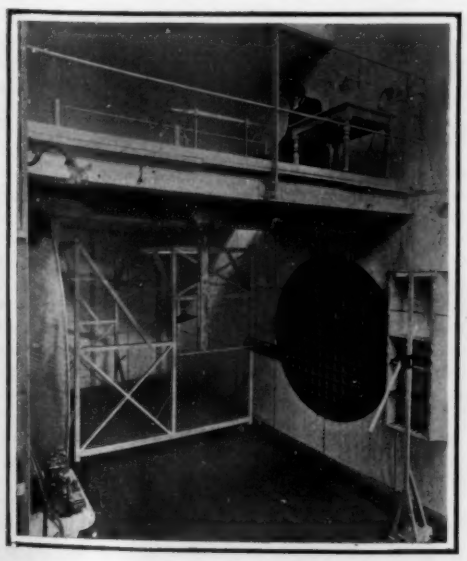


Fig. 6.—Experiment room of Eiffel's aerodynamic laboratory.

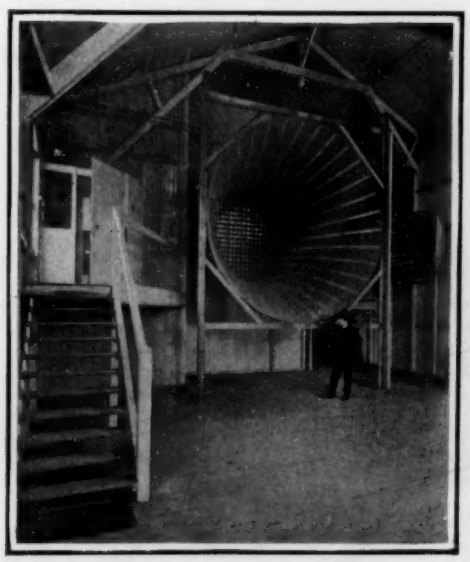


Fig. 7.—The inlet of the blower.

Fig. 8.—Arrangement of apparatus for measuring pressures at various points of the surface.

EIFFEL'S RECENT EXPERIMENTS ON THE RESISTANCE OF THE AIR.

is placed near the inlet of the blower, and not at its outlet, as is usually done. The air which leaves a blower is subjected to irregular disturbances, which cannot be overcome sufficiently to produce uniform and constant velocity over the entire surface. The pressure exerted upon the surface is transmitted to the balance in the room above, where the observer is stationed. The air enters the experiment room through a cellular diaphragm in parallel filaments. At the opposite end of the room is the mouth of the conduit which leads to the blower and which contains two iron-wire gratings of 2/5-inch mesh, placed about 40 inches apart, which almost completely eliminate all irregularities of flow. The air leaves the blower through a conduit which gradually enlarges and serves still further to assure regularity of flow. Hence, the velocity and direction of the air current are uniform throughout its whole section and, as the apparatus is entirely inclosed, it is not affected by the wind outside.

The velocities of the air current are deduced from the readings of manometers, and the results have been verified in the following manner: One of the surfaces exposed to the current was perforated with a large number of holes, in each of which was countersunk a screw, having at its center an orifice, 1/50 inch in diameter. By measuring with a small manometer the pressure produced behind each of these orifices, and integrating the result, the same resultant force that had been indicated by the balance was obtained.

We cannot here relate in detail all the interesting results which Eiffel and his assistant Léon Rith have already obtained in this laboratory. We will mention only a few of the more important conclusions.

Eiffel has proved that the value of the horizontal component, or resistance to the advance of an aeroplane, increases continually with the inclination of the surface to the horizon, while the vertical component attains a maximum at an inclination of 15 degrees, and thereafter diminishes very rapidly, and vanishes at 90 degrees, i. e., when the plane is vertical.

The surfaces employed in these experiments had a plane of symmetry parallel to the wind. In order to determine the directions of the air filaments in this plane, a short and very light wire, attached to the end of a thin rod, was placed at various points of the plane, and the position and direction of the wire were determined as accurately as possible. In most cases it was found that, especially near the front edge of the surface, the direction of the wire fluctuated rapidly between two fixed limits. This fluctuation in the direction of the wire is due to the fact that at any instant the air flows according to a definite, but not very stable, system, so that only a very small influence is required to pass from one system to another. The various possible systems of flow could be approximately determined by careful observation and comparison of the directions of the wire.

Fig. 3 shows the directions of the air filaments near a square surface, the plane of which makes an angle of 40 degrees with the direction of the current. Fig. 4 shows the directions of the stream lines near a surface inclined 80 degrees to the current. It will be observed that these lines are very variable and consequently very instable. The same fact is shown when the surface is perpendicular to the current. Fig. 5 shows the average direction of the air at various points in this case. In the two regions inclosed by the dotted lines, the disturbance is so great that no mean direction of flow could be determined.

In regard to the center of pressure, this coincides with the center of figures if the surface is horizontal, gradually moves forward as the inclination increases to 15 degrees, and thence recedes as the inclination is increased, and again attains the center of figure when the surface becomes perpendicular to the current. Finally, Eiffel indorses the almost universal preference of aviators for curved sustaining surfaces, and proves that, for a given resistance to forward movement, the curved surface always develops a greater lifting power than the plane surface, especially at small inclinations.

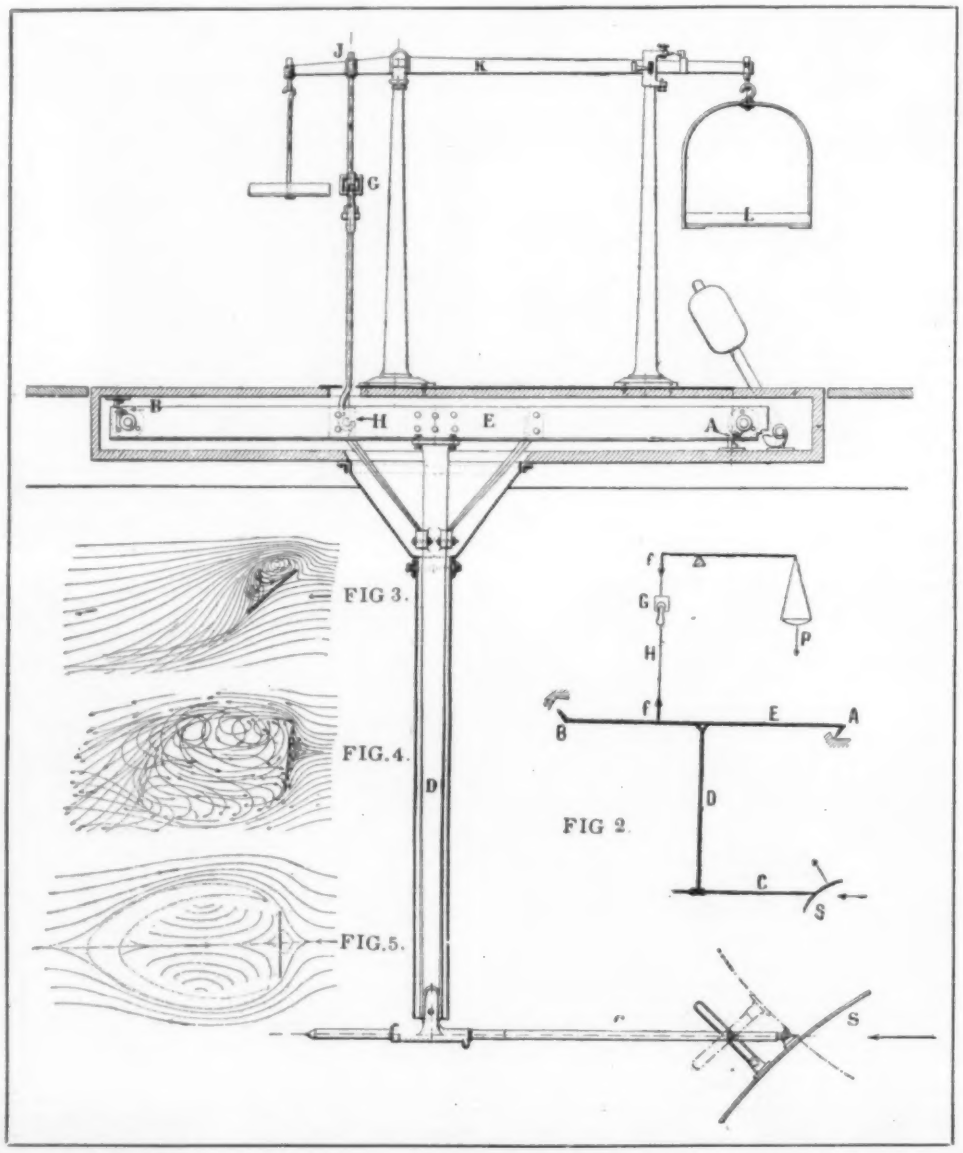


Fig. 1. The Eiffel aerodynamic balance. Fig. 2. Diagram of the balance. Fig. 3. Direction of stream lines near a square plate inclined 40° to the air current. Fig. 4. Stream lines near a square plate inclined 80° to the air current. Fig. 5. Stream lines near a square plate perpendicular to the air current.

The Transit of Halley's Comet.

The transit of Halley's comet and the expected immersion of the earth in the tail of that historic body have proven once more what may happen to the best-laid plans of mathematicians. The transit undoubtedly occurred, but whether or not the earth really encountered the tail seems to be a matter of considerable doubt. When the night of May 18th came, and the scientific world was all agog, the tail was so curved that the passage of the earth through it seemed only remotely possible. On the morning of the 20th a broad band of light that stretched along the horizon for a distance varying from 120 to 160 degrees proclaimed indubitably that the earth was still untouched, and that contrary to expectations, the comet was still in the east. Prof. W. W. Campbell, of the Lick Observatory, saw the comet visibly in the eastern sky. According to him, the tail was at least 140 degrees long and lagged far behind the radius vector. Because of the angle of 18-odd degrees which separates the earth's orbit from that of the comet, the curvature of the tail, to which this extraordinary misadventure may probably be traced, probably prevented the earth from coming in contact with it.

All the scientific expeditions which have been sent out to various parts of the earth will probably come back with nothing to report. Some of these scientific parties must have proceeded to their destinations at considerable expense. Thus Prof. Birkeland, of the University of Christiania, went to Kaafjord, in the northern part of Norway, for the purpose of noting whatever electrical and magnetic effects might be attributed to the comet's tail, and particularly to observe the relation of the aurora borealis to the comet. He has his own theory that the particles of a comet's tail are so highly electrified that they may, in some way, affect the aurora borealis. The failure of his expedition, which it is almost safe to assert, still leaves that theory unproved.

Similarly unsuccessful must be all the elaborate preparations made by meteorologists, navigators and physicists. The more important meteorological stations of the world sent up sounding balloons at frequent intervals on the 18th and 19th of May, for the express purpose of bringing down from the upper strata of the atmosphere some record of unusual happenings which might safely be attributed to the influence of the comet. All this labor is now in vain. Similarly, it is very unlikely that the instructions sent forth by the United States Hydrographic Office to wireless operators, charging them to note any curious and unusual effects on their instruments, will prove barren.

The expedition which was sent to the Hawaiian Islands by the Astronomical and Astrophysical Society of America for the purpose of observing the transit cables a preliminary report of complete inability to note any transit whatever. This was more or less expected. In 1882 a transit occurred which was fortunately observed by Mr. Finlay at the Cape of Good Hope. The comet of 1882 was followed by him "continuously right into the boiling of the limb." No sooner had it touched it, than it vanished as if destroyed. So sudden was the disappearance, that the comet was at first believed to have passed behind the sun. As a matter of fact, the observers at the Cape had witnessed a genuine transit. The experience of the observers at the Hawaiian Islands with Halley's comet seems to have been exactly similar. On the whole, this apparent failure to observe the creeping of a black speck across the face of the sun may be deemed a confirmation of our present theories that the bulk of a comet is much too flimsy to be detected in the blinding glare of our central luminary.

Although the passage of the earth through the tail of Halley's comet turned out to be an extraordinary disappointment, it is unfair to charge our mathematical astronomers with incompetence. A comet's tail is so capricious, so fluctuating a structure, it changes with such startling rapidity, that the predictions of any astronomer with regard to its behavior must always be stated with some reserve.

The tail of Halley's comet has conducted itself in a most whimsical fashion. In the middle of February, it was some fifteen million miles long. In April, it seemed to have vanished entirely. Then it grew again, until finally it attained a length that has been variously placed at twenty to forty million miles. It seems to have split longitudinally into three more or less well defined parts. When we consider that Morehouse's comet of 1908 (comet C, 1908) exhibited some extraordinary changes; that it repeatedly formed tails, which were discarded to drift out bodily into space, until they finally melted away; that in several cases tails were twisted or corkscrew shaped, as if they had gone out in a more or less spiral form; that areas of material connected with the tail would become visible at some distance from the head, where apparently no supply had reached it from the nucleus; that several times the matter of the tail was accelerated perpendicularly to its length; and that at one time the entire tail was thrown forward and violently curved perpendicularly to the radius vector in the general direction of the tail's sweep through space (a peculiarity opposed to the laws of gravitation), it is evident that a comet presents important problems for the future astronomer to solve. It is no wonder that Halley's comet should have disappointed us.

Correspondence.

MEASURING AEROPLANE HEIGHTS.

To the Editor of the SCIENTIFIC AMERICAN:

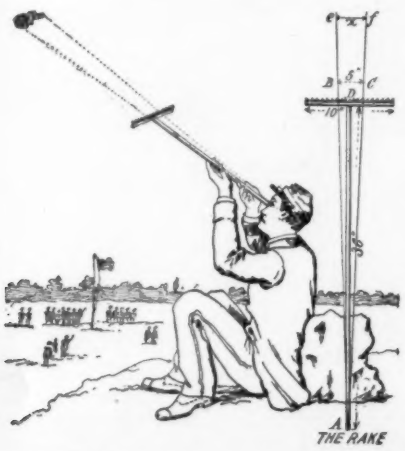
Replying to your communication of recent date, requesting me to forward a drawing of an apparatus which some French journal has stated I have for ascertaining the height of an aeroplane in flight, I beg leave to say that there is some inaccuracy in the statement as quoted.

Primarily, the apparatus used were merely a roughly-made "range rake," such as has been in use for some time in the Coast Artillery Corps for computing the "overs and shorts" that occur during their big-gun practice. Secondarily, in so far as accuracy is concerned, it cannot by any imagining be considered as accurate as a triangulation method employing two transits with a long connecting base line.

The "range rake" is simply a wand about three feet in length, having at one end a set of fine saw-teeth placed at right angles to the wand on a metal strip several inches in length. Measurements are taken between teeth to the right and left of the middle tooth.

The principle on which this depends is that of similar triangles, the same being illustrated by the accompanying diagram. From this diagram and description it can readily be seen that the short base line precludes any great accuracy in the computations.

However, to apply the facts to the particular flight



MEASURING ALTITUDE OF AEROPLANE WITH A RANGE RAKE.

BC : AD : : ef : Ax; ef=width of aeroplane, B C apparent width measured on the rake.

which was referred to in the French journal, I am of opinion, personally, that Paulhan actually attained an elevation of approximately forty-six hundred feet, for the following reasons:

1. The official figures were taken by two transits set one thousand feet apart. The solution of the obtained triangles gave him an altitude of 4,165 feet. The method and computations of the triangles were undoubtedly correct. The error, if any, was due to the fact that he attained his maximum height when crossing the line joining the transits. This so appeared to me. At that time, owing to the acuteness of the angle of elevation, it was impossible for either transit to take a reading, both being interfered with by the horizontal bases of the instruments. The maximum height as taken by these transits was when Paulhan was distant from the base line approximately one mile.

2. Paulhan had with him an aneroid barometer, corrected but not sealed. He stated that this registered a maximum of 4,600 feet (after being reduced from meters).

3. The maximum height as taken by Capt. Samuel Bottoms, Coast Artillery Corps, U. S. A., and myself with a "range rake" was 5,287 feet.

From all of the above I am of the opinion given above, viz., that Louis Paulhan actually attained a height of approximately four thousand six hundred feet at the Los Angeles meet, but am also of opinion that the official figure of 4,165 feet was the only one which could have been accepted under the circumstances.

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The output of the Clyde shipbuilding yards during April totaled 20 vessels and 60,000 tons, which is the largest recorded since July, 1907, when the output totaled 67,000 tons. The aggregate for the four months amounts to 154,000 tons, as compared with 98,000 tons in the corresponding period of last year. The total included a battleship. A fair amount of new work has been booked during the month, and prospects are good.

HOW CHICAGO IS SOLVING ITS RAPID TRANSIT PROBLEM.

BY D. H. STEVENS.

The city of Chicago has been hard at work rehabilitating its surface street-car systems, and completing plans for the new subway lines. The engineers of the city have estimated how many passengers enter and leave Chicago's six square miles of business area every twenty-four hours, and the results prove that the present lines are hopelessly overworked. During two normal business days of the past year it was found that on all of the lines running into the down-town district bounded by Chicago Avenue on the north, by Twelfth Street on the south, on the west by Halsted Street, and on the east by Lake Michigan, an area of about six square miles, every seventh passenger was without a seat. When it is remembered that the service cannot be improved much along present lines, it is clearly seen that a subway is imperative. At a conservative estimate, the next generation will see a demand for train facilities from the central district of the city equal to all facilities now available from the central part of New York city, with all its ferries, tunnels, subways, bridge and surface lines. To meet this need, the engineers have planned a system which it is believed will adequately meet this great demand for cars during the rush hours.

The complete system will be bounded on the north by Chicago Avenue, on the south by Twenty-second Street, on the west by Halsted Street, and on the east by Wabash Avenue. Four terminal stations will be built immediately at the boundaries of this subway zone; one at Chicago Avenue and North Franklin Street; one at Dearborn and Twenty-second Streets; another at Van Buren and Halsted Streets; and the fourth at Randolph and Halsted Streets. The new underground will begin where the four elevated lines now enter the district, and all surface cars from the respective quarters of the city will also converge at these four terminal stations, where all surface and elevated cars from the resident districts will become subway cars, and will remain under the surface until they again pass out of the district.

As shown in the front-page plan, a four-track route will run close to the surface of Wabash Avenue from Chicago Avenue to Twenty-second Street. This route will carry all through cars from the South and North Sides, two tracks being exclusively for surface cars and two for elevated trains. After passing to the opposite limit of the district, the trains from each direction will turn about and will return to their respective starting points by the same route.

From the West Side of the city two tubes will run in beneath Randolph and Washington Streets, as shown in the accompanying plan, and will turn southward on State Street, and then return to the West Side under Adams Street and Jackson Boulevard. After coming out into daylight at the Halsted Street terminal, these cars will also scatter to all points on the west side of the river.

To complete this first stage of plan one will cost about forty millions of dollars. Its capacity will be fifty per cent greater than that of all the traction lines now operating within the district. With the aid of surface cars to make short hauls within the business district, this plan will serve the needs of the city for many years.

An additional expenditure of forty millions will then build the second stage of this plan, when other busy streets will cover branches of the system. In this stage of the development will be found both loops and through routes for all parts of Chicago. Yet where the various tunnels cross one another there will be no grade crossings: one tube will dip in its course so as to pass completely under the other line. This will eliminate all danger of underground collisions.

A further expenditure of thirty-two million dollars will serve to complete the system, when every street within the subway zone will have beneath it a branch of the subway. Two, three, and four-track subway lines will honeycomb the whole area, and the entire district will be served by the most elaborate, yet the most efficient, subway system in the world. This plan, in its completed form, will cost about one hundred and twelve millions of dollars, and will serve the needs of the city at its present rate of growth until 1950. Improved methods of transportation will probably cause the business district to expand, and the subway will be built accordingly. It may ultimately be possible to remove every yard of rail and every car from the surface of down-town streets.

On our front page is shown a cross-section of one of the future stations on Wabash Avenue. As seen in this picture, the tracks lie close to the street surface. Because of the danger to certain building foundations, a low-level subway is impracticable, and the cost would be prohibitive. As the entire subway is to lie in the soft blue clay that underlies the business district, a special type of construction will be needed. The concrete core of the subway walls must be so constructed as to bear heavy pressure from any side, and the engineers have worked out a type of construction to meet this requirement. Stations of this type will be built in the center of every block on Wabash Avenue, and the platforms will be but a short distance below the sidewalk level. Underground walks will afford opportunity to cross the streets, or to walk parallel to the car line, past the basement windows of the department stores.

The cars will include the most modern improvements, such as side entrances, to permit the rapid handling of passengers, provided with automatic signals to show the motorman when all the doors are closed. The use of these cars will greatly reduce the length of stops at stations. The plans also provide for the housing of all underground utilities in suitable chambers. Every public service corporation will have its own chamber, as shown on the front-page engraving, in which will be accommodated all of its pipe lines within the subway zone. Particular care will be taken to provide for the future water supply, a very vital provision in the consideration of the future needs of the business district. These chambers will be easily accessible from the street surface, so that it will be a simple matter to inspect or repair the pine lines of any company. The cost of this gallery construction has been included in the foregoing figures, so that an expenditure of one hundred and twelve millions of dollars will give Chicago a complete traction system, and the best possible provision for her public utilities.

This comprehensive plan is the outcome of several months of investigation by City Engineer John Ericson. The result is a scheme of construction that is well adapted to meet the peculiar needs of a city that has its entire business interest within an area of six square miles. Whatever slight variations may be made in the plans during the progress of construction, the scheme for construction as here described will be the general foundation for whatever subways may be built.

The Current Supplement.

The Garratt flexible railroad locomotive is the subject of the opening article of the current SUPPLEMENT, No. 1795. The salient features of the locomotive are its extreme flexibility and adaptability for operation on steep grades and sharp curves. The mining of tungsten ore is described by Consular Agent Harry A. McBride, of Bilbao. From the beginning, American agriculture has been characterized by its extensiveness rather than its intensiveness. Land has been more abundant than labor. Prof. Homer C. Price contributes an article entitled "The Reorganization of American Farming," in which he points out that the problem which now confronts the American farmer is to adapt his soil to present conditions. William E. Stark presents the first installment of a paper on "Measuring Instruments of Long Ago." "Ilo, a Third Universal Language," is the title of an article describing a universal tongue which is intended to take the place of Esperanto, on which it is an improvement. Prof. Ralph Barton Perry writes on the prophecy of Francis Bacon. A profile puppet-show can be made as described by A. Roze. Some new electrical and physical apparatus are illustrated. Prof. E. A. Minchen reviews some applications of microscopy to practical science and modern knowledge.

The Difference Between a Sanitarium and a Sanatorium.

The words "sanitarium" and "sanatorium" are popularly understood to have the same meaning and are generally used interchangeably, when designating (or describing) places of refuge for sick people, but there is, in fact, quite a distinction between the meaning of the two words. In answer to a correspondent on this subject the Literary Digest says:

"The distinction between these words lies in the fact that they are derived from two different Latin roots. 'Sanatorium' is derived from the late Latin *sanatorius*, meaning *health-giving*. The term relates specially to 'an institution for treatment of disease or care of invalids; especially an establishment employing natural therapeutic agents or conditions peculiar to the locality, or some specific treatment, or treating particular diseases.' On the other hand, 'sanitarium' is derived from the Latin *sanitas*, from *sanus*, meaning *whole*, or *sound*. 'Sanitarium' relates more specifically to 'a place where the hygienic conditions are preservative of health, as distinguished from one where therapeutic agencies are employed.' Hence it is the province of a 'sanitarium' to preserve health, that of a 'sanatorium' to restore it. Care should be exercised in combining the proper vowels in these two words, in order to indicate correctly the derivation."

In our issue of May 14th we published an article on the utilization of wireless telegraphy in connection with a Chalmers-Detroit automobile in the Glidden tour. Through inadvertence, we neglected to state in the article that the wireless installation was devised by Dr. Lee De Forest.

THE CARTAGO EARTHQUAKE.

BY PROF. GUSTAVE MICHAUD, COSTA RICA STATE COLLEGE.

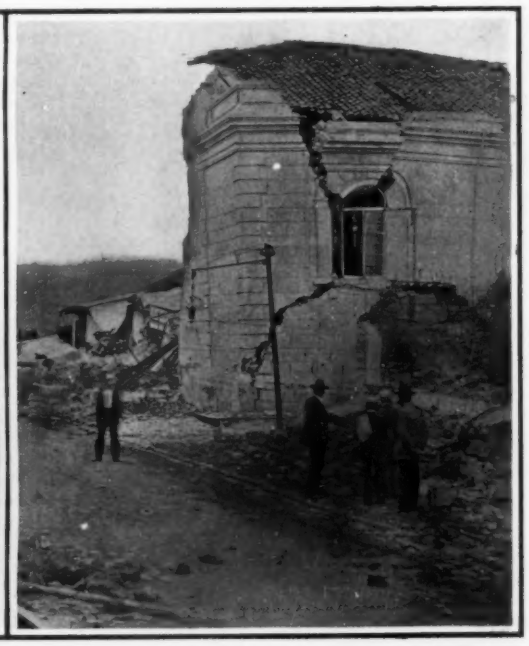
On May 4th, at 6:50 P. M., the city of Cartago, former capital of Costa Rica, was wiped out of existence by an explosive earthquake which lasted but a few seconds. The destructive motion was mainly vertical and began suddenly, that is, without the premonitory shocks which usually give most people time enough to run out from their houses. Immediately after the heavy up-and-down motion came a long series of smaller shocks, among which a gyratory motion was perceptible. The dust raised by the instantaneous fall of houses and public buildings was so great that many people thought they had escaped death by crushing only to die of suffocation. Twenty thousand people

A corner of the Palacio de la Paz.

El Palacio de la Paz (Palace of Peace) gift of Carnegie, just completed.

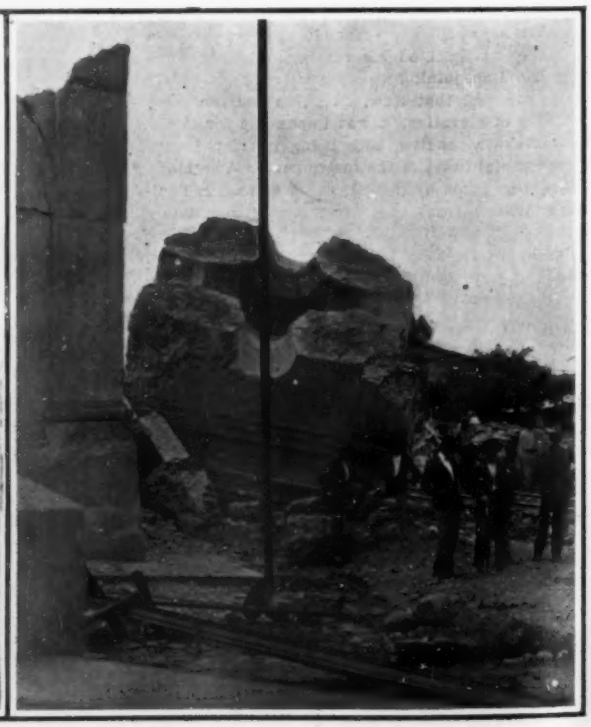
A primary school.

House of Poet Trogo, who was killed on the sidewalk.



Rear view of the wrecked convent.

Front façade of the convent. Note the absolute wrecking of the massive towers.



Top of church tower bodily torn asunder and thrown to the ground.

TERRIFIC RESULTS OF THE "EXPLOSIVE" EARTHQUAKE AT CARTAGO, COSTA RICA.

are left without shelter. As the writer is sending this relation (May 7th) 700 corpses have been dug out of the ruins. That number is rapidly increasing. The number of the wounded is not yet known. They are carried daily, by special trains, to San José. The destitution and suffering are intense. Persons who wish to help may do so through the American legation in San José.

During the year 1909 small earthquakes in Cartago had been rather frequent, and the writer, who had a seismograph in the Cartago College, began to send regular reports to the recently founded Strasburg Central Bureau of the International Association of Seismology. On April 13th, 1910, shortly after midnight, came a first warning of the impending catastrophe, in the form of a series of earthquakes, the third of which fissured many houses, destroyed some poorly built walls, and played great havoc among bottles and earthenware. This earthquake was generally felt on the whole Costa Rican plateau. On the following days smaller shocks, mostly of intensity III to V (Rossi and Forel scale) followed at the rate of some three to eight a day. The population in Cartago and San José became alarmed, and erected in the streets and public parks tents and sheds, in which they slept. The shocks had somewhat decreased in number and intensity when the fatal issue came.

Cartago is situated at an altitude of 4,700 feet, at the very foot of the huge volcano Irazu, which towers 11,500 feet above sea level. The Irazu volcano is considered as extinct, the only remnant of its former activity being a few *fumarolles* or steam jets, located at a considerable distance from the now silent and cold craters. At no time before or after the catastrophe have the fumarolles shown any symptom of increased activity. Moreover, the seismograph in Cartago gave for most earthquakes a direction which was almost perpendicular to that of the volcano. However, a few days before the destructive shock, the direction of the earthquakes became variable, and for some of them coincided with that of the Irazu. On May 4th the needle of the apparatus began writing the last chapter of the drama, and while so doing jumped out several times from the glass plate. Then the seismograph, which is a heavy inverted pendulum contained in a box some three feet high, was violently thrown against the wall; the glass plate fell from its shelf, and was broken in two.

Among the public buildings which are in ruins is the beautiful Palace of Peace, a gift of Mr. Andrew Carnegie. The palace had just been completed, the interior only being left unfinished.

HOW TO ACT IN CASE OF FIRE.

BY PERCY COLLINS.

Perhaps no single ejaculation is capable of producing so instantaneous and so widespread an alarm as the cry of "Fire!" Nor is this surprising when we remember that the fire fiend is each year responsible for an almost incalculable loss, both of life and of property.

Yet of all emergencies, none more than an outbreak of fire imperatively demands a preservation of one's power to act with coolness and decision. Often, by prompt and well-directed action, the threatened catastrophe may be averted; the loss of property, and what is still more important, the loss of human life, may be avoided.

Fire drill nowadays has its place in the routine of every well-conducted scholastic establishment; nor can it be doubted that the capacity for prompt and intelligent action thus inculcated in the minds of young people of both sexes has, in emergency, proved the means of preventing appalling disaster. But while this capacity for combined action is very desirable, there seems to be a danger of fostering it at the expense of what one may term "fire education." Every child should be taught, by means of precept and experiment, what to do when a fire breaks out in his own house. He should be instructed how to go to work coolly and methodically, either to extinguish the flames, or—if necessary—to escape from the building. Lessons of this kind, imparted by practical methods, would become a source of strength in after life, and would go far to check the recurrence of fire outbreaks, with their entailed loss of life and capital.

Take, for example, the case of an overturned oil-lamp. There is a sudden and alarming blaze; but if action is taken at once, the damage may be confined to the carpet, cloth, or what-not upon which the lamp actually lies. To throw water on the conflagration is useless. The burning oil will only be forced over a larger area. The aim should be to absorb the oil and smother the flame as much as possible, and this may best be done by means of some non-flammable powder—such as flour, sand, earth from the garden, or anything of the kind.

Another point worth remembering is the use of the soda-water syphon as an extinguisher. Suppose that a lamp or candle has ignited a curtain and that the flame has run up the fabric. A syphon of soda water, held as shown in the accompanying photograph, and squirted over the flames, will work wonders. Not only does the force with which the liquid leaves the tube allow of its being directed well above the operator's head, but the carbonic-acid gas with which the water is charged helps to deaden the flames.

How to act for one's safety, or to assist another, in the case of burning clothing cannot be better told than in the words of Prof. John Marshall. He says: "If the dress of a woman catches fire, she should at once lie down on the floor, and should crawl in this position either to a bell-pull or a door, and call for assistance; or she should roll herself in a rug or blanket. In the event of a man rendering help, he should at once lay the patient down, take off his coat and roll her in it, unless he can obtain a blanket or rug, or roll her on the carpet. If a woman renders assistance, she must be careful not to allow her own clothing to touch the victim, but to hold a rug or blanket in front of herself while approaching the flames."

Prompt action without rashness or self-balking hurry, is the keynote of success in fighting the fire fiend. This applies especially to those who wake from sleep to find the house on fire. Not a moment should be lost, but there should be no wild rushing from a window to a door and back again. First an attempt should be made to get down the stairs. To escape through passages filled with suffocating smoke, tie a wet handkerchief over the mouth and nose, then crawl on the hands and knees, for the smoke tends to rise with the hot air, and will be less dense close to the floor.

But if the whole of the lower part of the house is burning, and escape by means of the stairs is impossible, preparations must be made for leaving through the window. Tie all the sheets and blankets together by means of "reef-knots," which will not slip, no matter how much strain is put upon them. Then drop the bedding or mattress from the window, in order that there may be some kind of break in the event of a possible fall. Finally, make one end of your improvised fire-escape fast to the bedpost, drop the other end from the window, and after making sure that it reaches to, or almost to, the ground, go down it boldly hand over hand. It should be added that in the case of inexperienced persons, there is always considerable risk of a dangerous fall resulting from this means of exit; therefore it should be undertaken only when all other means of escape have failed.

In conclusion, a few words may be added respecting the treatment of burns and scalds prior to the arrival of a doctor. The main point to bear in mind is that the air is to be excluded from the affected part as quickly as possible. This may be done by

(*Concluded on page 451.*)

Blazing oil from overturned lamp extinguished by use of flour.

To avoid drawing burnt or scalded limb from clothing cut apparel away with sharp scissors.

Manner of tying sheets, etc., together to form an escape rope.

Crawling method of escape from passages filled with smoke. Handkerchief holds wet sponge in place.

A syphon makes a handy and an efficient fire extinguisher.

Method of using knotted blanket or sheet rope for escape by windows.

THE HEAVENS IN JUNE

BY HENRY NORRIS RUSSELL, PH.D.

JUNE, though less exciting from an astronomical standpoint than May, is still a month of more than usual interest.

Halley's comet will, of course, still be the main object of attention. At the beginning of the month it is excellently placed for observation, about midway between Regulus and Alphard (α Hydrae) on a dark sky, setting after 11 P. M. It will however be much less conspicuous than the week before, and will seem to shrink and fade rapidly as it recedes from us. Its distance on the 1st is about fifty million miles, and this increases steadily, at the rate of three and one-half million miles a day—to which the earth's motion in one direction contributes about one and one-half million miles, and the comet's motion in the opposite direction the remainder.

Its apparent motion in the sky is slow, for it is moving almost directly away from us. It still travels eastward and southward among the stars, continuing the line of its earlier path, but very much more slowly, covering only 13 deg. during June, and 5 deg. during July.

During the first ten days of the month it will still be a fine naked-eye object. Then the new moon will begin to flood the evening sky with light, and drown it out. By the time she is out of the way again the comet will be 125 million miles from us, and equally far from the sun, so that little can be seen of it without a field-glass. With the aid of the latter it can probably be followed all through the month.

The display which this comet has given us during May is probably the finest of the last fifty years.

Curiously enough, its only rival in the last quarter-century is the great comet which appeared so unexpectedly last January. This was at one time much brighter than Halley's comet (owing to its close approach to the sun), but its tail was not so long, and it was too deep in the evening twilight to be seen to the best advantage.

Daniel's comet of 1907, though intrinsically of about the same magnitude as Halley's comet, was never within fifty million miles of the earth, and so never afforded nearly as fine a spectacle.

Back of this is a long barren interval. The last previous comet which was at all conspicuous to the naked-eye was the great one of 1882. This was one of the grandest on record, and had a tail over 100 million miles in length, but this was directed almost away from the earth, so that it never looked more than 35 deg. long—as against over 80 deg. for Halley's comet before it left the morning sky. Before this comes Coggia's comet of 1874, with a tail of 50 deg. long, but the last comet, fully comparable in appearance with our visitor of this year, is the great comet of 1861, whose tail was at one time 120 deg. in apparent length. As in the present case, the earth passed through the tail without any sensible effects other than a general illumination of the sky on the night of passage. Three years earlier, in 1858, appeared Donati's comet, by common consent the finest of the last half of the nineteenth century.

Several of these comets, especially that of 1882, were really much larger affairs than Halley's; but the very favorable circumstances of the present return make it comparable, as a spectacle, with any of them, so far as can be judged from the records.

The last news at the moment of writing is that its head proved perfectly transparent during its transit across the sun, and that its tail is so much curved in its own plane that the earth did not reach it till long after daybreak on the 19th. Before dawn this morning it was a magnificent object, extending from the eastern horizon half way across the sky, till it was lost in the Milky Way. Its total length up to the invisible head was fully 120 deg., according to observations here, and 140 deg. as seen at the Lick Observatory a few hours later.

THE HEAVENS.

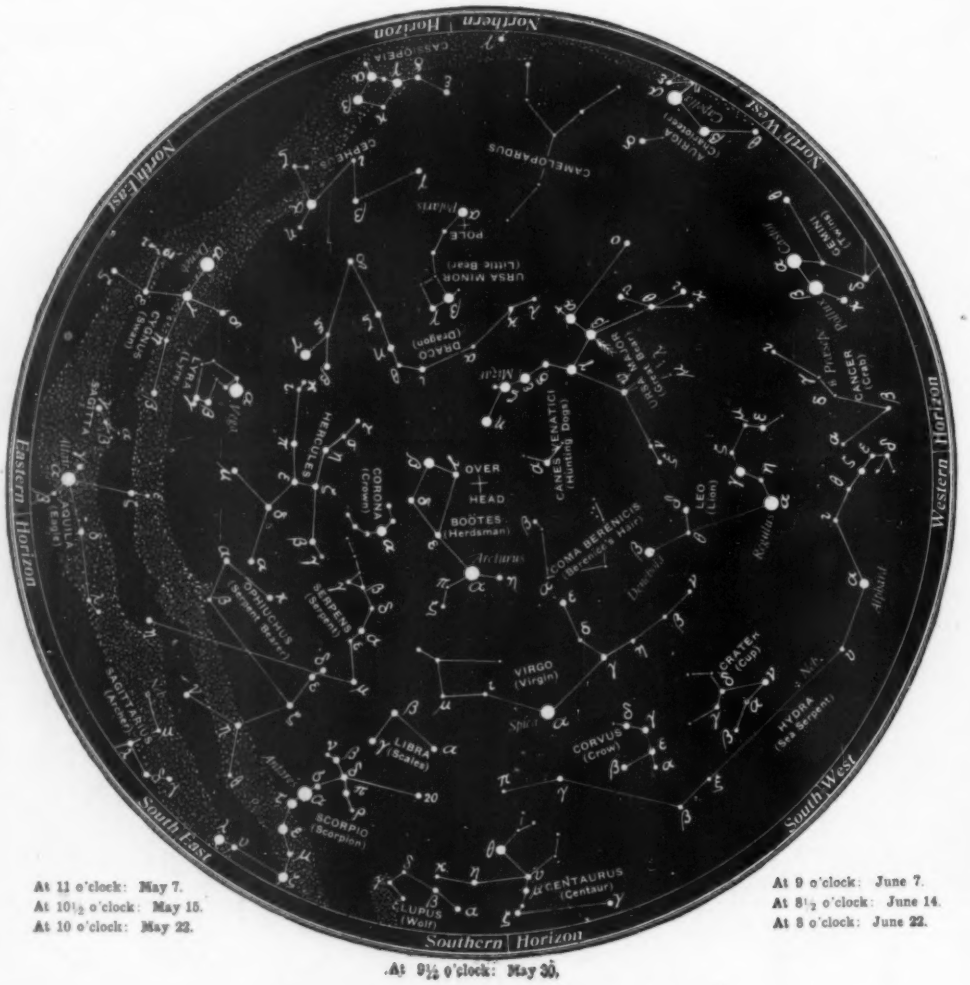
As our marvelous visitor fades in the western heavens, we may turn once more to the old familiar constellations. In the north, below the Pole, is Cassiopica, low on the horizon. Above her is Cepheus, and higher still the Little Bear, standing poised on its tail above the Pole. Between this and the Great Bear are the long coils of Draco. Our initial shows the truly formidable aspect of this monster, whose form, coils and all, can be traced with decided likeness among the stars themselves. The two bright stars β and γ in the Dragon's head are very conspicuous. Two others, of which only one is shown on the map, make up with these an irregular quadrilateral. The faintest star of this, ν Draconis, is an interesting double, separable with a field-glass of high power—the distance of the components being almost exactly one minute of arc.

The star α Draconis, about midway between the bowl of the Little Dipper and the end of the handle of the Great Dipper, is noteworthy as the pole-star of the ancient Egyptians. About the year 3500 B. C. the celestial pole, in the course of its precessional motion, passed very near this star, so that it held the same place in the heavens then that Polaris does to-day.

In the northeast we see the great cross of Cygnus, and the brilliant Vega, and due east Altair has just risen. Higher up is Hercules, and south of him Ophiuchus, entangled with the Serpent which he carries. Boötes is right overhead, Arcturus being some 20 deg. south of the zenith. Low in the southeast is Scorpio, not yet fully risen. On the right and above is the insignificant group of Libra, and the extensive one of Virgo, now brightened up by Jupiter, in the southwest. Below this, all along the sky from west to south, stretches the mighty length of Hydra, with the Crow and Cup resting upon its back. Due south, far down below Virgo, are many of the stars of the Centaur and the Wolf. Observers in low latitudes, near the tropics, can see below these the two brightest stars of the constellation which, though among the most brilliant in the heavens, have no Greek, Latin, or Arabic names, being too far south to be known to the ancients. The easternmost of the two, Alpha Centauri, is known to all students of astronomy as our nearest neighbor in the heavens—only half as far away as Sirius, which, so far as is now known, comes next.

Farther east, and best seen a little earlier in the evening, is the Southern Cross.

Leo, in the west, and Cancer and Gemini below, complete our list. This region of the sky will be the closest watched of all during the month, for the comet is there.



At 11 o'clock: May 7.
At 10½ o'clock: May 15.
At 10 o'clock: May 22.
At 9½ o'clock: May 30.
At 9 o'clock: June 7.
At 8½ o'clock: June 14.
At 8 o'clock: June 22.

NIGHT SKY: MAY AND JUNE.

THE PLANETS.

Mercury is morning star all through the month, being best observable about the time of his greatest elongation on the 19th, but as he is then south of the sun, and rises little more than an hour before him, the present opportunity is unfavorable.

Venus is likewise a morning star, rising before 3 A. M. and very conspicuous.

Mars is an evening star in Gemini and Cancer, setting more than two hours later than the sun.

Jupiter is in Virgo, visible all the evening. He is in quadrature on the 27th, and comes to the meridian at 6 P. M.

Saturn is morning star in Aries, rising about 2 A. M. in the middle of the month. On the morning of the 5th he is in extremely close conjunction with Venus, the two being only four minutes of arc apart—too close to be separated by the unaided eye. Unfortunately, the closest approach is at about 9 A. M. by eastern standard time, when the planets are invisible in the daylight, and they will be about a quarter of a degree apart at 3 A. M., when we can last see them. Observers on the Pacific coast will be able to follow them until they are almost too close to be separated by the eye.

Uranus is in Sagittarius, and crosses the meridian about 2 A. M. in the middle of the month. Neptune is in Gemini, too near the sun to be observed.

The moon is new at 8 A. M. on the 7th, in her first quarter at 11 A. M. on the 14th, full at 3 P. M. on the 22d, and in her last quarter at 11 P. M. on the 29th. She is nearest the earth on the 5th, and farthest away on the 18th. In her course around the heavens she passes Venus and Saturn on the morning of the 4th, very closely. These conjunctions, like that of the planets two days later, happen after the sun has risen for the Eastern States, but will be of interest to western observers.

Besides these, she passes Mercury on the 6th, Neptune on the 9th, Mars on the 11th, Jupiter on the 15th, and Uranus on the 24th, none of them closely.

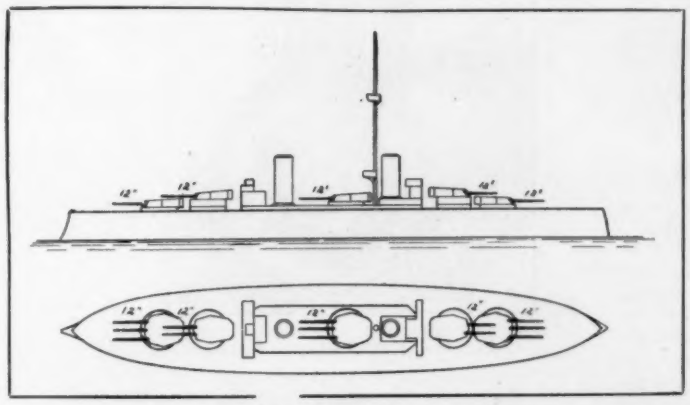
By the addition of magnesia to castor oil, it is possible to obtain a mixture in the form of a powder, which contains fifty per cent of castor oil and produces the therapeutic effects of the pure oil, and yet is odorless and tasteless. The nature of the compound formed was not completely determined until recently. It is now proved that it is not a magnesia soap, but a simple mixture, for the oil can be extracted in unaltered condition by ether, or by treatment with hydrochloric acid, which dissolves the magnesia.

A 13-GUN SHIP; THE LATEST DREADNOUGHT DEVELOPMENT.

BY PERCIVAL A. HISLAM.

There have been many modifications of the "Dreadnought" design since it was first introduced in 1905. The American modification is distinguished by the center-line arrangement of the gun turrets, the German by the powerful secondary armament and by the reported introduction of the triple turret. It has remained for Italy—the home of constructive genius and the real birthplace of the dreadnought itself—to combine in one ship the twin turret, the triple turret, and the center-line arrangement.

Four ships are under construction for the Mediterranean power. One, the "Dante Alighieri," was laid down last summer, and is to be launched in September. In the case of this vessel, her power has been exaggerated, for instead of carrying twelve 12-inch guns, as reported, she will have only ten. In the case of the other three ships, named "Conte di Cavour," "Leonardo da Vinci," and "Giulio Cesare," it is difficult to say whether their power has been under or over rated. According to first accounts, they were to carry eight 14-inch guns. It now turns out, however, that they will have no fewer than thirteen 12-inch weapons. This is a larger number of single-caliber guns than has ever been mounted in a modern ship, although the Japanese "Satsuma" and "Aki" each carry four 12-inch and ten 10-inch, to say nothing of twelve 6-inch. The arrangement of the guns in the Italian ships is distinctly novel. There will be three three-gun turrets, one forward, one aft, and one amidships, while a twin turret will be placed forward and aft, so as to bring its guns to bear over the lower turret. There will thus be a full broadside of thirteen 12-inch guns, with a fore-and-aft fire of five. The secondary battery will consist of eighteen 4.7-inch rapid-fire guns, besides the same number of 3-inch. Three under-water torpedo tubes will be fitted. The displacement will be 24,000 tons, the main armor belt 12 inches thick, and the speed 22 knots.



NEW ITALIAN BATTLESHIPS WHICH WILL BE THE FIRST TO CARRY THIRTEEN TWELVE-INCH GUNS.

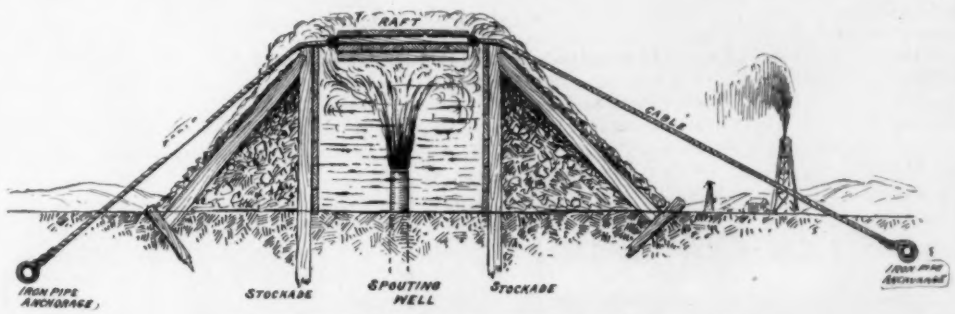
The arrangement of the armament in the "Dante Alighieri" is precisely the same as that in the other three ships, save that the midship turret is suppressed, and that the after turrets are on a lower level than those forward. As will be seen from the accompanying sketch, the deck runs straight from bow to stern in the three other ships. The "Dante" will have a displacement of 18,300 tons and a speed of 23 knots. The four ships are to be completed in 1913.

HOW THE LAKEVIEW GUSHER WAS CAPPED.

BY H. C. CARR.

Last week's issue of the SCIENTIFIC AMERICAN contained a description of an oil well in the midway district near Bakersfield, Cal., which on March 15th suddenly blew out the drilling tools and became the Lakeview Gusher, the largest oil gusher in California, blowing out at the rate of over 40,000 barrels of heavy crude oil a day. The force of the gas pressure was so terrific that the derrick was ripped to pieces, and oil spray was literally sent for miles in every direction. How to cap this well was a serious problem. For several weeks no attempt whatever was made to check the flow. A tentative attack was then made to fasten down a wooden roof over the head of the well. Although the roof was made of 16 by 16 timbers, the gusher tore them to splinters.

The following plan was then successfully adopted: The gusher had by this time broken out in several small oil fountains in addition to the main stream. These additional openings were smothered by means of successive bulwarks of brush and sand. A stockade of heavy planks was then built around the spouting well. The walls of the stockade were 15 feet high. On one side of the stockade a slanting runway was constructed. A heavy raft 15 by 20 (approximately) was then built, resting on this runway like a ship on the ways. Heavy wire cables were fastened to the four corners of the raft. The cables at the two lower corners were made fast to heavy pipes buried 10 feet under ground. The cables attached to the upper corners of the raft, as it lay on the ways, were run over the top of the stockade. At a favorable lull these upper cables were hauled taut, and the raft was dragged into position like a hatch. The two loose cables, which had served to haul up the raft, were then made fast to buried pipes. The result was that the stream of oil was hurled against what was virtually a raft anchored in midair. The raft, held up by the force of oil, is about 15 feet above the mouth of the well and just above the stockade. Although this does not actually stifle the gush of oil, it has very much lowered the height of the fountain, and thus has resulted in a vast saving of oil.



ARRANGEMENT OF STOCKADE AND RAFT WITH WHICH THE LAKEVIEW GUSHER WAS CAPPED.

A National Good Roads Laboratory.

The Agricultural Appropriation Bill approved March 3rd, 1893, contained an item appropriating $10,000 to enable the Secretary of Agriculture to make inquiries into systems of road management throughout the United States, to make investigations in regard to the best methods of road making, and prepare publications and assist agricultural colleges and experiment stations in disseminating information on this subject. In pursuance of this authority, the Office of Road Inquiry was established.

During the next two fiscal years, the appropriations and the wording of the bill remained the same. The appropriation for the fiscal year 1897 was reduced to $8,000, and a provision was added authorizing the investigation of road-making materials in the several States. The appropriation remained $8,000 annually during the fiscal years 1898, 1899, and 1900, and no change was made in the wording of the bill, although the name of the office was changed from "Road Inquiry" to "Public Road Inquiries" in the fiscal year 1899.

The Agricultural Bill for 1901 carried an appropriation for $14,000 and provided for conducting experiments in the city of Washington and elsewhere, and collecting, digesting, reporting, and illustrating the results of such experiments. The appropriation for 1902 was $20,000, and the bill provided for the investigation of the chemical and physical character of road materials. The language of the appropriation bills has remained practically unchanged up to the present time, except that the name of the office was changed from "Public Road Inquiries" to the "Office of Public Roads" and a statutory organization was provided in the Agricultural Bill approved March 3rd, 1905. In the appropriation bill for 1909, the rent or purchase of road-making machinery was forbidden. The total appropriations to the fiscal year 1909 inclusive amount to $473,440. The estimate for 1909-10 as approved by the Secretary of Agriculture is for $126,450.

The Office of Public Roads is under the jurisdiction of the National Department of Agriculture as shown above. It has no administrative duties and exercises no control whatever over the roads of the United States, its functions being entirely scientific and educational. No appropriations are made by the national government for roads except on government reservations. At the present time there are sixty-seven officials and employees on the rolls of the office. The work of the office is divided into three branches, namely, the laboratory work, which is organized as the Division of Tests; the engineering work, which is known as the Highway Division; and the economic, statistical, road management, and miscellaneous work, which is organized as the Division of Road Management.

As the Division of Tests, which may be regarded as a National Good Roads Laboratory, is considered to be the most completely equipped road material laboratory in the world, we give the following detailed description of the plant and work: The Assistant Director and Chemist has charge of the Division of Tests. He has as his assistants a testing engineer and an assistant chemist. The chemical laboratory is under the immediate direction of the assistant chemist, and the physical testing of materials is under the testing engineer. There is also in the Division of Tests a petrographic laboratory with a petrographer in charge. The routine testing of materials conducted by the Division of Tests consists of microscopic and chemical analyses of specimens to determine their mineral composition and proper classification, and physical tests to determine their cementing value, hardness, toughness, resistance to wear, water absorption, and density. (Bulletin 79, Bureau of Chemistry.)

In addition to the routine tests, special studies are made regarding the use and composition of asphalts, oils, tars, compounds, various emulsions, and salt solutions, with the view of preventing dust and preserving road surfaces. (Bulletin No. 34.) Other investigations include research into the decomposition of rock powders (Bulletin No. 28, Circular No. 38, and Farmers' Bulletin No. 239), the testing of clays for use in paving brick, burnt-clay and sand-clay roads (Bulletin No. 27 and Farmers' Bulletin No. 311), and the corrosion of iron culverts, bridges, and fence wire (Bulletin No. 30 and Farmers' Bulletin No. 239).

The equipment for the physical testing laboratory is as follows:

Large impact machine for testing paving brick; impact machine for testing binding power of rock dust; impact machine for testing the toughness of rocks; Olsen testing machine for tensile, cross-bending and compression tests, capacity 20,000 pounds; Richle testing machine for testing tensile, cross-bending, and compressive strengths, capacity 200,000 pounds; delicate platform scales; hydraulic machine for molding briquettes; torsion balance; abrasion machine for testing resistance to wear of rocks; vacuum pump; diamond saw and grinding laps for making thin rock sections for microscopic examinations; ball mill for grinding rock samples into powder; centrifugal pump; diamond core drill; small rock crusher; grinding disk for testing the hardness of rock samples; battery of pebble mills for pulverizing rock powders; Westinghouse air compressor; hot-air bath; gas furnace; and a complete cement-testing outfit consisting of a Fairbank's torsion machine; Gilmore's needles; standard sieves; briquette molds; soaking tanks, etc.

The equipment for the machine shop where testing machines and other apparatus are made and repaired is as follows:

Speed lathe; engine lathe; drill press; power hack saw; precision lathe; saw table; universal trimmer. The chemical laboratory is equipped with the necessary chemical apparatus used in making analyses of rocks, clays, cements, and bituminous substances. It is provided with compressed air, vacuum, gas, hot and cold water, steam, and electricity. The petrographic laboratory is provided with a petrographic microscope of the latest Fuess model, which besides the usual attachments is provided with a revolving analyzer in the tube to aid in the determination of very low doubly refracting mineral, and a Schwartzman scale for the measurement of optical axial angles. The methods used for examining and classifying rocks are fully set forth in Bulletin No. 31.

The road material laboratory was established in December, 1900, and from that time until November 30th, 1908, 3,018 samples of road material were tested from practically every State in the Union. The results of tests made up to January 1st, 1908, and a brief description of the present methods of making routine tests are shown on Form No. 28.

NEW TWO-CYCLE MOTORS

DEFECTS OF THE TWO-CYCLE ENGINE AND HOW THEY ARE OVERCOME.

A belief is growing among gas engine experts that the greatest improvements in gas and gasoline motors must come in the future from some type of engine which gets increased power from its cylinders by eliminating the idle revolution of the four-cycle type. It is conceded that four-cycle design has practically reached the limit of its possibilities, the advent of the automobile having drawn the services of the brightest men in the gas engine field, the result of whose work is seen to-day in the splendid examples of gas engines found in even the cheaper kind of automobiles. However, many designers feel, as was expressed by one prominent engineer, that "it is inconceivable that the four-stroke cycle with its small utilization of one-half of the piston strokes, will be accepted as the finality of development; the two-stroke cycle as now applied is equally unsatisfying for reasons that are familiar to all students of the question."

It is apparent that the chief efforts toward improvement are now being made with a view to eliminating the defects heretofore common to the two-cycle type.

The chief defects of the usual two-cycle engine may be summed up as follows:

1. The explosive mixture is taken into the crank case, resulting in leakage and in possible explosions in the base.

2. The new charge comes into direct contact with the hot burned gases, causing possible pre-ignition and some loss of gas at the exhaust.

3. The charge is not large enough in volume because the crank case is an altogether inefficient compressor on account of its very large clearance. This means a small charge and also a large percentage of dead gas left in the cylinder.

4. The power is not increased materially by the double number of explosions because of the weak charges and poor economy.

Several recent two-cycle engines meet these defects in different ways. The Newcomb engine was recently exhibited before the Automobile Club of America. This is a two-cycle engine using the crank case to supply air only. This air blows out the previous charge and furnishes oxygen to burn the next charge of fuel. The fuel is injected directly into the cylinder from a plunger pump, the quantity being controlled by regulating the stroke of the pump. The gasoline is directed downward into a small cup on the head of the piston. When the piston rises this cup or pocket is in the vicinity of the spark plug, so that there is always an ignitable mixture near the plug, even when running on very light load. This arrangement avoids several of the defects of ordinary two-cycle engines. The charge is limited, however, by the amount of air which can be supplied from the crank case, which would scarcely exceed 75 per cent of the displacement of the piston, leaving the other 25 per cent and the clearance space filled with burned gas. This engine will undoubtedly be more powerful, economical, and reliable than the ordinary two-cycle motor.

Another improved type of two-cycle engine is that employing a differential piston. This engine leaves out the crank case entirely as a means of supplying the charge or air and compresses the charge initially in an annular chamber formed by a differential or two-diameter piston. Two cylinders are worked together, the lower piston of one compressing the charge for the other. This permits getting a full charge and large capacity, though the loss of fuel through the exhaust is likely to be greater. The leakage loss and base firing are eliminated. This type of motor is used on the Elmore automobile and a light-weight engine weighing but 3½ pounds per horse-power and constructed after the design of J. W. Broderick is now being manufactured for aeroplanes and other aeronautic purposes.

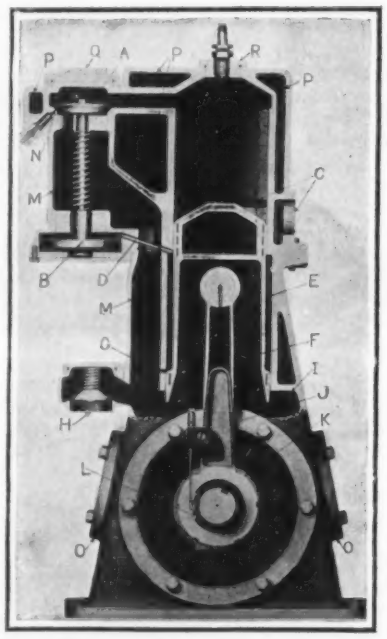


Fig. 1.—Shortt two cycle motor.

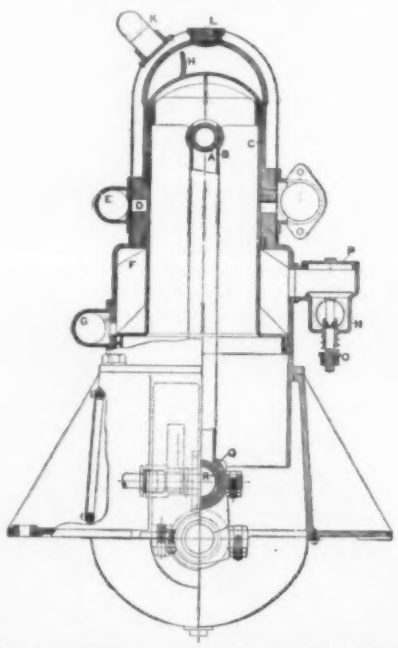


Fig. 2.—Longitudinal section through the Broderick two-cycle motor.

A good idea of the method of operation of this motor can be had from the diagrams we reproduce. The cross-section of one of the cylinders shows the large compressor piston on the lower end of the working piston *C*. On the down stroke the large piston draws in a charge of gas from the carbureter through the automatic inlet valve *M*. On the up stroke it compresses this charge in the chamber *F* above it and in the pipe *G* leading across to the inlet port of the second cylinder. Just before the piston of the second cylinder opens the exhaust port, it uncovers the inlet port *D* and the charge compressed in the transfer pipe *G E*, leading from cylinder one to cylinder two, passes into the cylinder and is directed upward by the deflector *H*. In the motor shown, the connecting rods *A* are of steel tubing for the purpose of saving weight. The spark plugs are located in the dome-shaped cylinder heads, where they are most effective in igniting the mixture. This type of two-cycle motor offers the advantage that there is no possibility of leakage of the initial compression after the crank-shaft bearings have become worn, and there is no necessity of making these bearings heavier and longer than usual for the prevention of undue wear. Neither is there any trouble from back fires in the crank case, which sometimes cause serious damage.

The new cycle motor is a recent invention of C. A. Dawley, member of the American Society of Mechanical Engineers. This engine has some features of both of those described above. It uses a differential piston and handles the charge in an annular chamber, but it also compresses air in the crank case. Owing to the enlarged diameter of the piston in the crank case, the air supply is in excess of the piston displacement. The air displaces the exhaust and scavenges the cylinder before the new charge is admitted. The admission of the new charge is controlled by the valve *F* in Fig. 5, and the timing is such as to introduce the charge after the cylinder is cleared of burned gases, but before compression commences. This evidently will give a full charge of air and fuel and prevent any loss of fuel or premature ignition. When used on gasoline this engine may use a carbureter, in which case an extra rich mixture would be drawn into chamber *B*, while the additional air required for combustion would come from the crank case. Or a fuel pump may be used as in the Newcomb engine, except that in this case the gasoline would be delivered into port *M* and then blown into the cylinder by the charge of

(*Continued on page 449.*)

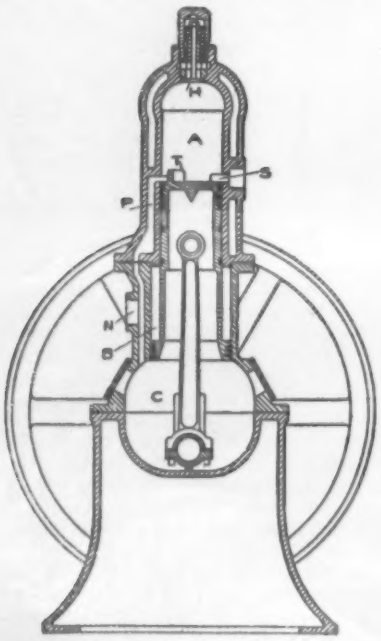


Fig. 4.—Section of Dawley engine.

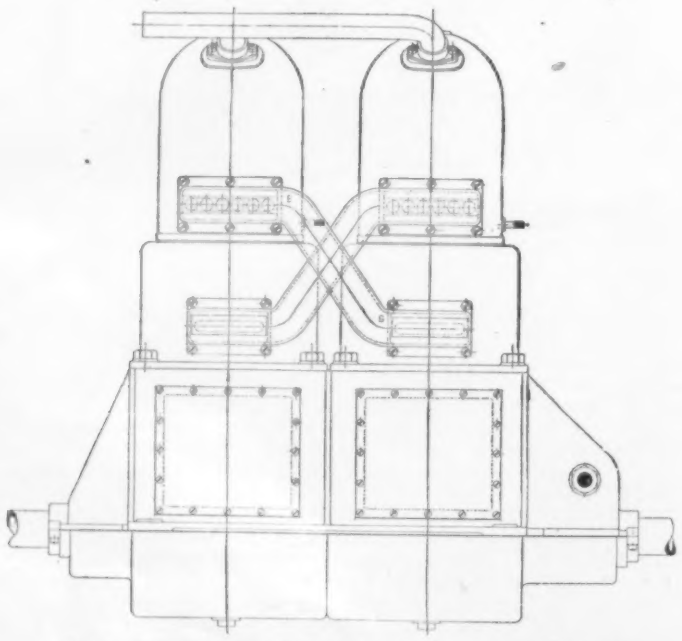


Fig. 3.—Side elevation of Broderick two-cycle aeronautic motor.

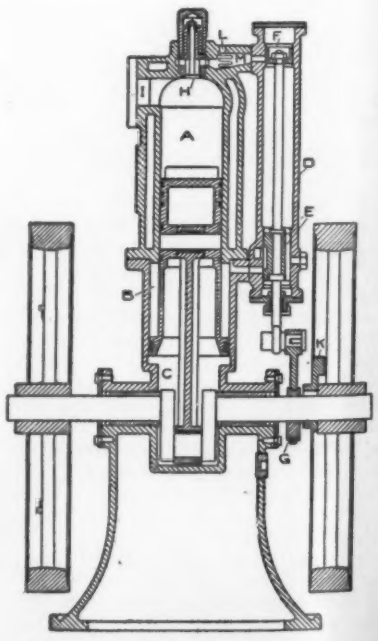


Fig. 5.—Section of Dawley engine.

NEW TWO-CYCLE MOTORS.

A ROUGH AND READY GALVANIC BATTERY.

BY A. J. JARMAN.

The best battery for experimental work in the workshop or laboratory is one of the rough-and-ready type that will give a moderate current of electricity of say three or four amperes with an electromotive force of 1.5 to 3 volts. Such a battery is suited for the exciting of a powerful electromagnet, for magnetizing purposes, operating an induction coil, and for electro silver plating, electro brassing, or electro coppering either by the hot or cold process, and for electro gilding. The following description will enable anyone who can handle woodworking tools to construct such a battery consisting of two cells, capable of being coupled so as to give the current of one large cell or in series so as to yield the current of one cell and the electromotive force of two. This latter plan is the one best suited for coppering, brassing or electro nickeling. This type of battery has been used, and is still used by the writer for all the purposes mentioned, for over five years, so it has been put well to the test of experience.

The wood used in making the battery must be thoroughly well seasoned. An old board that has been kept years in an office or a loft will prove to be just the thing required. The board should be 1 inch thick. Cut a strip 5 feet long and 8 inches wide. Plane this smooth all over and then cut three pieces 13½ inches long, and three pieces 5½ inches long. The latter will form the ends and central division of the battery. The side pieces must be grooved so as to receive these pieces with a very nice fitting joint as shown in Fig. 1. The bottom piece must be made as shown in Fig. 2, with two pieces of wood cut exactly 5 inches square, this size being the inside measurement of each cell. These squares must be held in place by means of screws that are inserted from the underside of the bottom board and penetrate to within ¼ inch of the outer surface of the squares. They should also be coated with a thick shellac varnish (not glue) before being fastened in place. The grooves in the side pieces and the ends of the division pieces must also be well coated with thick shellac varnish, after which the pieces should be driven tightly together and held by nails or screws. Nails driven diagonally make the best job because they will draw the woodwork together more firmly than screws, and resist direct strain better. The object of using shellac is to insure a perfect acid-proof joint, and the 5-inch square pieces where pressed into position form a bottom so firm that no acid liquid will penetrate.

When the battery has been put together it must be lined on the inside with a coating of burning-hot pitch. Use an old saucepan to melt the pitch in. Pour some into one of the cells and tilt the battery first one side then another until all four sides have been submitted to the hot pitch. Pour the pitch back into the saucepan, take a strip of square or flat iron, make one end red hot, and press this well into the corners and around the joints at the bottom, so as to secure a perfect coating of pitch at these joints. Now pour the hot pitch into the cell again so as to be sure that all parts are well covered. Treat the second cell in like manner. Having the case now well put together, finish the outside by giving it two coats of shellac varnish mixed with crocus (oxide of iron). This paint will resist the acid solution used in the cells and give quite a nice finish to the work. To complete the battery procure two zinc cylinders 7 inches high, 3½ inches inside diameter, and ⅛ inch thick. Also two round porous pots 3 inches diameter and 7 inches high. Also two carbon plates or blocks 7 or 8 inches long, ½ inch thick, and 2 inches wide. Attach two brass battery clamps to these with a strip of sheet copper folded over the top of the carbon block. This is an important item. Its use will protect the brass clamp from being corroded by the acids. The zinc cylinders can be purchased with a copper strip and binding screw attached. The zinc cylinders must be amalgamated by dipping them into sulphuric acid 1 part, water 8 parts, and then rubbing all over inside and outside with quicksilver. Place these zincs in the wooden vessel. Make up a mixture of sulphuric acid 1 pint, water 8 pints in a stoneware pitcher, and allow it to become cold. In another vessel make a mixture of water 4 pints, bichromate of sodium or potassium 12 ounces, sulphuric acid half a pint. Allow this also to become cold. The battery is now charged by pouring the bichromate mixture into the porous pots, around the carbon blocks, and then pouring the sulphuric acid mixture into the outside space around the zinc cylinders. The battery is now ready for any purpose required and will keep in good action for about six hours continuously. When not in use the zinc cylinders must be removed and placed into a stoneware crock filled with water, and the bichromate mixture must be returned to the vessel it was made in. The carbon block can also be stood on end upon blotting paper or in a wide-mouthed pickle bottle. The sulphuric acid mixture can be allowed to remain in the wooden battery cells. For intermittent use such a battery will work well for months and meet every requirement for small work, either in the workshop or laboratory. No amount of hard use will injure it, if well put together as described. No acid solutions will affect it, although the liquid may be left in the cells year in and year out.

Fig. 2.

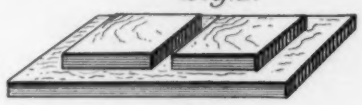
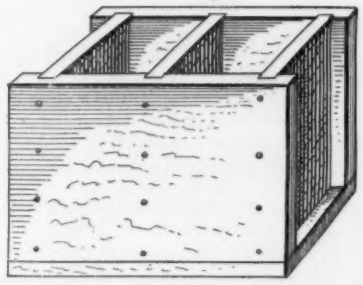


Fig. 1.



A ROUGH AND READY GALVANIC BATTERY.

SAFE GASOLINE TANKS.

BY DR. F. W. BREMEC

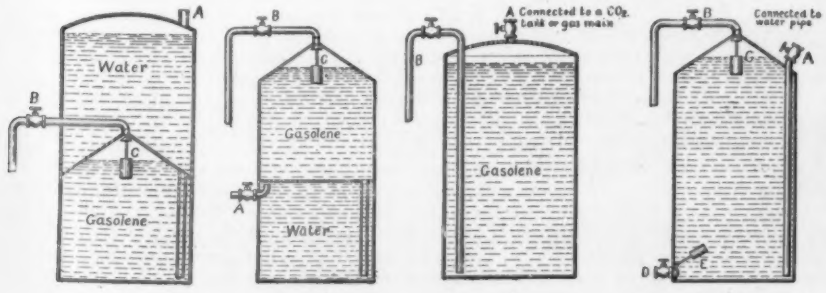
As gasoline explosions are due to a mixture of gasoline vapor with air (accidentally ignited, of course), I think the air in a gasoline tank could well be replaced either by water or a non-oxidizing gas such as carbon dioxide, after the manner here illustrated.

In the first two designs, water is used. In Fig. 1 the weight of the water forces the gasoline out of the lower tank through the stopcock *B*. The valve *C* is so constructed that it floats when the water reaches it, closes the opening, and thus prevents the water from flowing out. To refill the tank with gasoline, a suction pump is connected to the stopcock *A* and the gasoline is siphoned into the lower compartment through the stop-cock *B*. The latter prevents the gasoline from escaping.

Fig. 2 is practically the same, but to discharge the gasoline through the stopcock *B* air must be pumped into the lower part to force the water into the gasoline tank above. To refill this tank with gasoline, the stopcock at *A* is opened, letting the air out, and the weight of the water then siphons the gasoline into the tank above through the valve, and stopcock *B*.

In Fig. 3 a carbon dioxide tank is connected to the pipe *A* and the pressure of the gas then forces the gasoline out through the pipe *B*.

In Fig. 4 the stopcock *A* is connected to the water main or pipe when the pressure of the water forces the gasoline out through the stopcock *B*. The valve *C* prevents the water from escaping into the gasoline cans through the stopcock *B*. To refill the tank, the stopcock *A* is closed and stopcock *D* is opened, and the water flowing out through the latter will draw the gasoline into the tank through stopcock *B*. The valve *E* is adjusted to sink in gasoline and thus close the outlet, preventing escape of gasoline through the stopcock *D*.



SIMPLE METHODS OF MAKING GASOLINE TANKS SAFE.

PLUG CONNECTOR.

To make a plug connector for use in an electric light socket, all that is required is a burned out incandescent lamp and a number of feet of heavy lamp cord. Break the glass globe out of the lamp, leaving only the base. Then break away the glass tube that protects the leading-in wires, being careful not to injure them. Now untwist about a foot of the lamp cord, scrape the ends clean and slip a short length of rubber tubing over each end. Solder the ends to the leading-in wires in the lamp base and then push the rubber tubes down over the joints. Fill the socket with plaster of Paris, letting it project up above the top of the plug about an inch, so as to form an insulated top to screw the plug in by. This plug connector is suitable for small motors, portable lamps, and any other apparatus that draws only a small current. It cannot be used for large currents, as the heavy current would fuse the leading-in wires in the plug.

A SIMPLE APPARATUS FOR EMPTYING CARBOYS.

BY H. H. P. CLARKE.

A very simple, effective and easily set up apparatus for emptying carboys of acid, etc., may be made in the following way from materials found in every laboratory. This will be found to be far superior to the acid pump or the old-fashioned method of tilting the carboy, catching the liquid in a jug, and then pouring it into bottles. For no fumes can escape, and this is an important factor when dealing with strong ammonia or hydrochloric acid (spirits of salts).

Say one wishes to fill with hydrochloric acid or another liquid any number of bottles from a carboy.

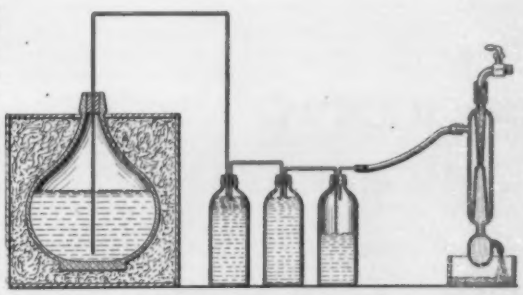
Fit every one of the bottles with two-holed rubber corks, and then through each hole put a piece of glass tubing bent in the form of a right angle with sides about three inches long. Connect one piece of glass tubing in one bottle to another piece in another bottle with a small piece of rubber tubing, the free piece of this bottle with another piece in another bottle, and so on until you have all the bottles connected up in one straight line.

Connect the free tube at one end of the line with a piece of rubber tubing to a long bent glass tube passing to the bottom of the carboy.

Attach the other free tube at the other end of the row of bottles to a glass filter pump or any other suction apparatus, with a piece of thick-walled rubber tubing. Then we have the apparatus as illustrated herewith.

Turn on the water tap connected with the filter pump, and the acid will be drawn up the tube leading from the carboy and into the first bottle. As soon as this is filled, the acid will run into the second bottle, and so on until the carboy is empty or the requisite number of bottles are filled.

If one hasn't many corks, all that is necessary is to fill say three or four bottles. When these are filled, they can be disconnected and others put in their place. But it must not be forgotten to turn off the water tap, and so stop the flow of liquid before making the change.



APPARATUS FOR EMPTYING CARBOYS.

If the liquid in the carboy is sulphuric acid (oil of vitriol) or any other liquid that attacks rubber, the two bent tubes connecting bottle to bottle may be made in one piece, and if care is taken to push the ends of the tubes below the end of the corks, the liquid won't reach up to them, and so they will not be hurt in the slightest. In fact, no rubber connections may be made use of except from the suction pump to one end of the line of bottles, though, of course, it is more convenient to use them.

A glass filter pump is the best to use, because any fumes that may perhaps come over have no corroding effect on it, as they would have on a metal one.

MAKING YOUR OWN PERFUMERY.

BY A. S. ATKINSON.

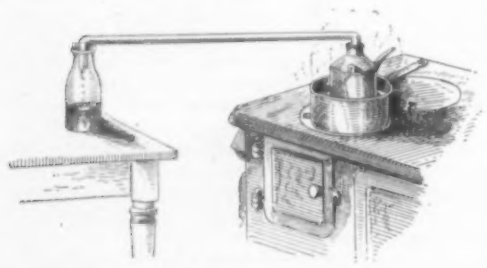
The manufacture of perfumery has always seemed a difficult process to many, and without doubt the blending of certain kinds of perfumes is a matter of much scientific and skillful manipulation; but on the other hand, the most commonly used perfumes can be made at home with simple apparatus and without much expense or trouble. In many parts of the country, flowers are so abundant that one can harvest all that are needed for manufacturing at home perfumes enough for a year's use.

A perfume garden should prove as profitable as one of fruits or vegetables. We plant gardens for cut flowers and for flower seeds, but few raise flowers for perfume making. Enough perfumery is sold in this country annually to make a yearly tax of nearly ten dollars on every family. This amount is not evenly distributed; but each woman spends enough to make it worth while, if she has the garden space, to try a hand at making her perfumes at home.

One must devote time to the cultivation of certain flowers, which thrive luxuriantly in the vicinity. In many parts of the country roses thrive so luxuriantly that fields can be sown with them, and an abundant crop raised. In other sections the rose is too slow-growing for this purpose, but the violet takes its place. Again, it must be the jasmine, the tuberose, the orange blossom, or lavender. Whatever flower it is that thrives and possesses delicate but powerful fragrance should be chosen for the work.

Direct distillation is the most satisfactory way of making perfumery. The still is a simple affair, and it can be made out of articles found in the average home. Take an ordinary tin oil can, scour it, and purify it of all oil odors. Stop the spout completely, and fit a cork in the top, through which the oil is poured. From a hardware store get four feet of copper tubing (tin or galvanized iron pipe may also be used). The tube should be bent downward at the ends.

The tin can should be filled with a pound of flower



HOME-MADE PERFUME STILL.

petals gathered fresh in the early morning. Pour over these petals eight fluid ounces of alcohol. Then put the can in a saucepan half filled with water, and place on a stove, where the water can be kept at the boiling point. A hole should be cut through the cork of the can just large enough to receive the metal tube. Place a quart jar on a table nearby, and insert in it the other end of the tubing. This jar should not be sealed, or distillation will not go on properly.

When the water boils, the alcohol in the can is heated, and this process extracts the perfume from the flower petals, and gradually causes distillation through the tube into the cold jar on the table. The alcohol thus distilled will carry with it the true attar of the flowers. Alcohol has a peculiar property of extracting and holding the scent of flowers. As fast as distillation goes on, the contents of the jar should be emptied into glass bottles, and securely corked and sealed with paraffin. In blending perfumes of several flowers, do the mixing after each one has been distilled separately. Do not mix the flowers in one still.

Another method of using this still is to employ water instead of alcohol for distillation. Instead of attar we get the essential oil of the flowers, and this rises and floats on the surface of the water in small globules, which must be skimmed off carefully, and immediately bottled and kept cool and air tight. When sufficient oil is obtained, it should be mixed with alcohol to retain the odor indefinitely. One may distill with water any number of kinds of flowers, and with the essential oil properly bottled, blended perfumes can then be made. A few drops of several kinds of oil are poured into a bottle containing a certain amount of alcohol, and when shaken thoroughly one has a delicious fragrance for home use. For instance, eau de cologne is made by pouring into a glass bottle a pint of alcohol, and adding half a drachm of home-made attar of rosemary and twenty drops each of the attar of orange peel, lemon peel, and bergamot peel. The distillation of these fruit peels is another desirable home industry. Cut up fresh orange or lemon peel and place it in water in the tin can, and heat as for use in flower leaves. The essential oil of these peels will then be gradually distilled into the other receptacle. Skim off the globules, and confine in corked bottles.

Besides distillation, we have the process of absorption, which anyone can do at home with little trouble and expense. It is slightly more complicated, but it will extract the perfume of more delicate flowers, such as the violets, with greater success. This process consists of covering two large shallow pans or soup plates with a layer of melted suet. The layer should be half an inch or more thick. When the fat has hardened, gather the violets, jasmine, or tuberose flowers, and cover the suet thickly with them. Then place one plate over the other, and force down firmly. Wrap the plates tightly in paper, so that the perfume will all be retained. In twenty-four hours the suet will have absorbed nearly all the perfume. Then quickly remove the dead petals, and replace with more fresh ones. Repeat this operation for several days or even for a week, so as to secure a strong supply of odors. When enough petals have been robbed of their odor, remove the top plate and cut the suet into small pieces, and drop them into a wide-mouthed bottle or glass jar containing alcohol. The transference should be made as quickly as possible, and with least exposure to the air. Then close the bottle or jar, and seal with paraffin to make air tight. As the suet absorbed the fragrance of the petals, so will the alcohol rob the suet of its concentrated extract. Every day the bottle should be shaken a little, and in a fortnight the alcohol should be poured off through a strainer into bottles and corked.

Besides making the liquid perfumes, one should consider sachet powders and perfumed pastes. These have their use in every household. A rose paste is made by steeping rose leaves in water, and pounding with a mortar until reduced to a paste. This maceration should be thorough, and can be done with an ordinary rolling pin. Now add a drop or two of your home-made attar of rose, and permit the paste to dry in an air-tight receptacle. The paste will grow quite hard, and can then be cut into any shape desired. A piece placed in a drawer will scent the place for a long time. If the pieces not in use are kept air-tight they will retain fragrance indefinitely, and will always be ready for instant use. Laid in linen and clothes presses, they add that subtle fragrance to the fabrics which so many like.

Sachet powders are as numerous and as varied in fragrance as colognes. One may compound them out of flower petals, spices, and perfumes to suit individual preferences. The art of making sachets is very simple and inexpensive. If we add to these attars and essential oils such simple articles, purchasable at any drug store, as iris root, musk, and cochineal (the last for coloring only) and such spices as cloves, cinnamon, and ginger, we have all the materials that a small laboratory requires for making a dozen kinds of popular sachets. Lavender seeds raised and cured at home make a sachet suitable for those who like this odor. Another is manufactured by mixing iris root and ground cloves with a little musk and attar of roses, the whole moistened with a little alcohol, and then rolled and kneaded into a paste, which in time grows quite stiff. A few pieces of this distributed around in the clothes press will add a delicious odor to garments. For gifts, appropriate bottles and ribbons or boxes may be purchased cheaply at the stores, or silk and damask can be obtained for concealing sachet or perfumed pastes, and pin cushions may be made and scented indefinitely by inclosing a good piece of the perfumed paste in the center.

AN EXPERIMENT IN SOUND.

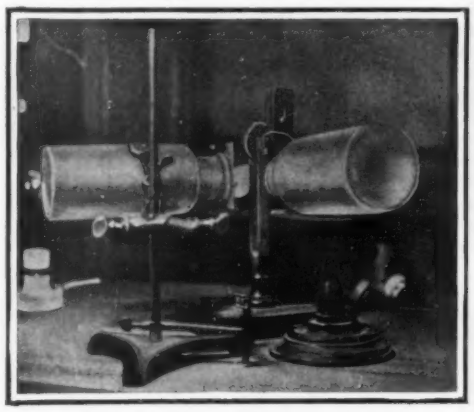
BY W. K. CARR.

Those who have had the good fortune to travel through a virgin tropical forest could hardly fail to have been impressed by the death-like stillness which pervades all nature between the hours of 1 and 4 P. M. This is the thermal noon of these regions, when all life, weary with the battle with the terrible heat, seeks repose in a much-needed siesta. No sound is heard save perhaps the slight rustling of a leaf, or the plaintive grunt of a tardogradus as he answers the call of his mate, or reaches out for a new caucho leaf with which to satisfy a never-ending appetite.

Under these circumstances Humboldt, the great German traveler, who was camping twelve miles from the falls of the Orinoco River, was astonished to find that no sound from this source reached his ear, while eight hours later, during the night, when the woods were rendered a perfect pandemonium by the shrieks of panther, jaguar, and monkey, the sound of falling waters broke with astonishing clearness upon his ear. What is the explanation of this phenomenon? And why, for example, do the citizens of Washington hear so distinctly, at night, the heavy trains as they pass over the Potomac railroad bridge, while during a calm, sunshiny day they listen in vain for the noise of the moving cars? The very natural explanation that the noise of the day traffic masks the sound of the cars does not suffice, as the experience of Humboldt proves. Some light is thrown upon this problem by a recital of the experience of the writer, when as a lad he stood upon a bluff forty or fifty feet high, and overlooked a large, level, low ground, from which point he could see the hunters loading their guns, the flash of their discharge, and the falling game, but not a sound reached his ears; while again, say five minutes later, with conditions apparently unchanged, even the conversation of the sportsmen became audible.

Prof. Tyndall has described this phenomenon, and attributed it to large masses of air, different in temperature and density from the surrounding atmosphere, drifting in between the ear and the source of sound. These "ear clouds," for veritable clouds they are, as far as the human ear is concerned, though perfectly transparent to the eye, possess in a marvelous degree the faculty of reflecting sound waves.

Following is the description of a simple experiment which, if thoroughly understood in all its bearings, will enable one to explain some of the most apparently complex phenomena in nature. Everything has its own period of vibration, that is, the rate at which it naturally swings, or vibrates—not only a tuning fork, but a column of air, and even a house, a tree, or a ship. Other things being equal, the longer the object the slower the swing; just as a tuning fork with long prongs swings slower, that is, gives a lower note, than one with short prongs, which swings faster and gives a higher note. Now take a fork giving the note C, which is due to 512 vibrations per second, energize it by bowing or by striking it with a hammer, and hold the fork before the mouth of a bottle, say 6 inches deep and 2 inches in diameter. Instantly you hear an increase in the intensity of the sound, because the column of air inclosed by such a bottle will vibrate the same number of times per second as the fork. Now hold a second similar bottle *between* the prongs of the fork, as in the accompanying photo-



AN EXPERIMENT IN SOUND INTERFERENCE.

graph, and the sound is practically extinguished, because the crests of the waves entering one bottle coincide with the troughs of those entering the other. Under these circumstances there is always interference, or silence. Now introduce a piece of cardboard between the mouth of the bottle and the vibrating prong; the conditions of interference are destroyed, and loudness is restored. But an ear cloud is quite as effective as a piece of cardboard. Place a burning match or a hot poker beneath the mouth of either one of the bottles, and as the thin layer of warm air reaches the opening it acts as a curtain, reflects the sound waves, and instantly the loudness of the fork is restored. Thus is demonstrated a significant and wonderful fact, the power of a thin layer of air to reflect sound quite as effectively as a board. Now, what are the physical conditions obtaining during the day between the ears of the citizens of Washington and the bridge over the Potomac River? The sun is shining, the atmosphere is still, a hot stratum of air rises from a metal roof, another slightly cooler from a grass plot, another of a different temperature from a concrete street, etc. Many strata of different temperatures intervene between the ear and the bridge. As we have just observed the effect of one stratum, we can readily realize that several would possess the power of completely extinguishing the noise of the moving trains. At night, on the contrary, the air is homogeneous, the waves are unimpeded, and strike the ear with astonishing clearness.

Bearing in mind these facts, many apparently inexplicable phenomena become as clear as the noonday sun.

The use of towing tanks to determine the best form of ships is much older than is generally supposed. A recent article in Engineering describes work of this character done by David Napier on a model of a channel steamer, the "Rob Roy," which in 1818 inaugurated the steamship service between Greenock and Belfast. The hulls of famous Aberdeen clippers, we are told, were modeled on results obtained in a tank 12 inches wide, 16 inches deep, and 10 feet long.

RECENTLY PATENTED INVENTIONS.

Pertaining to Apparel.

COMBINED CORSET-COVER AND BUST-SUPPORTER.—JENNIE MARX and EMMA MAIER, New York, N. Y. The object of this invention is to provide a new and improved corset cover and bust supporter, designed to be worn over the corset to form a corset cover, and arranged to properly support the bust and enabling the wearer to adjust the parts for the purpose and without danger of displaying the adjusting devices through shirt waists of fine thin texture.

FASTENER FOR GLOVES AND OTHER ARTICLES.—L. W. BROWN, St. Louis, Mo. If a glove fits closely it is very difficult to effect a closure of the ordinary spring button clasp, the half sections of which are respectively secured on the vent flaps of the glove. To enable the easy, quick, and reliable closure of the two parts of a spring button clasp, a novel attachment has been provided and constitutes the feature of improvement.

HAT-HOLDER.—E. J. GUILLARD, New York, N. Y. One embodiment of this invention comprises a casing, adapted to be secured to a hat, having therein spring controlled slides, provided with holding members guided on the inner rim of the casing, the action of the said holding members being substantially controlled by manually operated means connected with the said slides in the casing.

Electrical Devices.

ELECTRIC FURNACE.—H. W. HIXON, Philadelphia, Pa. An object here is to provide a device in which the zinc is fed into the furnace, the top of which is kept closed so that the zinc vapor is forced to escape at a lower point, preferably the tap hole. To this end Mr. Hixon provides a furnace with a top of double construction so that an upper door may be opened and a charge fed in while the lower door is shut, thereby keeping the zinc vapors within the furnace.

Of Interest to Farmers.

BUG AND WORM KILLING MACHINE.—L. THORTVEDT, Glyndon, Minn. This invention relates to mechanical means for removing and killing bugs and worms, that infest plants or bushes while growing, and the object is to provide details of construction for a power-actuated machine which is convenient to control while operating, and that is particularly well adapted for the removal and killing of bugs upon growing potato vines.

AUTOMOBILE MOWING-MACHINE.—C. G. DELANO, Berkley, Mass. This invention provides mechanism for propelling and operating a mower by power; provides traction mechanism for the mower adapted to be guided in rear of cutter bar; provides mechanism disposed in operative position in advance of traction mechanism; provides means for lifting the bar off the surface of the ground to avoid obstacles thereon; provides traction mechanism which may be utilized for miscellaneous power purposes, and a suitable reciprocating mechanism for the knives of the bar and operating connections therewith.

COMBINED HAY TEDDER AND MOWER.—W. F. SCHANZLIN, Lima, Ohio. An object of the inventor is to provide means whereby the hay can be tedded and turned during the mowing operation. A further object is to provide a device rapid and clean in its operation. Still further to provide means for adjusting the height of the tedder frame from the ground.

STALK-CUTTER.—J. MICHALKA and F. A. MICHALKA, Cameron, Texas. A purpose of the invention is to provide a machine that will not only cut standing stalks at a point near the ground, but which will practically at the same time cut the stalks in very short pieces, rendering it easy to plow the stalks under to enrich the soil, while any fragments that may remain on the surface will not in any manner interfere with the cultivation of a crop.

Of General Interest.

ANCHOR.—J. W. NEAL, Kealia, Hawaii. The invention belongs to that class of anchors in which a number of flukes are carried on a yoke frame and have a limited rotary movement relative thereto to engage in the mud or sand. It has in view an anchor in which the flukes are detachably connected and may be increased and decreased in number so that the anchor may offer the requisite resistance.

JIG.—W. A. BRADLEY, Spokane, Wash. The invention provides a device for rapidly and thoroughly separating the values from crushed ores, by means of which the gangue or tailings can be reconcentrated and which provides efficient means for forcing water or other liquid rapidly back and forth through a screen, to assist in the separation of the material.

REVERBERATORY SOUND-HORN.—W. A. CHAPMAN, Smithville, Ark. The invention enables the manufacture of sound amplifiers as used with talking machines, at a reduced cost; provides for increasing the artistic attractions of the room through action of light, a reduction in size of the horn heretofore required for the attainment of the given volume of sound, the control of volume and tone of sound commensurate with size of room in which it is placed, the elimination of all harsh and discordant notes, which are rendered true, full, resonant and in a natural manner; prevent mingling of sounds with those external, and affords a self-contained and perfectly balanced amplifying horn for sound reproducing machines.

DENTAL CUSPIDOR.—I. M. HAIR, Union, S. C. An object here is to provide a portable cuspidor which may be flushed by a stream of water operated by compressed air. A further object is to provide a device in which the flushing operation may be performed through the instrumentality of a foot lever attached to the device, thereby permitting the dentist to use both hands in other work.

FISH-NET.—D. P. GILSTRAP, Brownwood, Texas. The intention in this instance is to provide a woven net formed of intermeshed cords without floats, sinkers, drawstrings and the like encumbering attachments, and which will run freely upon a single supporting cord. A further intention is the provision of an improved spring trip for the cord. It acts as an animal trap as well as a net.

STAIR.—J. C. TOLIVER, Ainsworth, Neb. The stairs are of that class in which a chute or wheelway is provided on each side of the steps constituting the stair proper. The invention consists in the construction and arrangement of the chute on the sides of the stairs proper, whereby dust, dirt, or other material that may accumulate upon the stairs may be swept or pushed directly off of the same into the chute.

BOAT.—H. W. VANIMAN, Cincinnati, Ohio. The purpose of the inventor is to provide a non-sinkable and non-oxidizable boat comprising a plurality of sections, sundry preferably two of which are of greater size for the center and capable of receiving the other sections therein in nested relation, the said larger sections being then secured together.

BAG-HOLDER.—B. BUSH, Kennedy, N. Y. Among the principal objects which the present invention has in view are: to provide a bag holder to hold the opening or top of a bag square and in an inclined position; to provide a holder for a bag which will yield to the variation in length caused by the filling of the bag; and to provide a structure which is light, simple, and efficient.

STOPPER-RETAINER.—A. C. BOGGS, JR., Fort Dodge, Iowa. The aim in this case is to provide a spout or stopper retainer for oil cans, which can be applied to cans of various types, which can be secured to the spout of the can after the can is finished, which does not interfere with the flow of heavy oil through the spout, and which does not interfere with the introduction of oil into the can.

PYROGRAPHIC POINT.—L. QUOSBARTH, Newark, N. J. This invention pertains to improvements in the construction of tools or points of pyrographic burners, thermocauters and cauterizing tools, and to the means for securing the tip or point in place. The main object of the inventor is to so form the tip and the securing means therefor that the tip cannot work loose in use, but may be instantly and easily removed when desired to replace or repair.

Heating and Lighting.

LAMP.—W. S. RYAN, Viola, Ill. The present invention not only has in contemplation the location of the supply reservoir in the lamp post or casing, but also the feed tank which supplies the fuel to the lamp, together with means for introducing fluid pressure above the free surface of the fuel in both the reservoir and feed tank, to respectively discharge the fuel in the reservoir to the feed tank above and thence feed the fuel under the pressure to the lamp.

BAKING-STOVE.—J. A. COPPRIDGE, Browns Summit, N. C. This invention is an improvement in baking stoves, being especially designed as a stove for use in baking bread, and has for an object to provide a simple construction which will be efficient for the purpose, can be easily taken apart and stored in compact form so it will be convenient for camping purposes.

Machines and Mechanical Devices.

MEANS FOR THE PROPULSION OF VESSELS.—R. P. NIELSEN, Tranebjerg, Samsö, Denmark. The improvement relates to the propulsion of vessels and has for its object to provide a cheap and effective propelling mechanism. The pairs of chains being set in motion the vessel is propelled and owing to the inclination of the plates of the blades, they tend to raise the vessel and thereby facilitate its passage through the water.

AUTOMATIC PHOTOGRAPHIC-PRINTING MACHINE.—G. W. FERGUSON, Plymouth, Wis. The aim of this inventor is to provide means for rapidly printing photographs from negatives by giving each photograph the same time limit of exposure, by means of an automatic arrangement, which makes each photograph exactly the same. By this method photographs may be printed whenever desired without the aid of sunlight as in the old method.

DISPLAY-MACHINE.—J. S. ANDERSON, Newport, Ky. Among the principal objects which the invention has in view are: to provide a sign in which the exposed matter is continuously changing, and in which the change simulates a dissolving view; to provide a driving mechanism which is positive and smooth in its operation; and to provide a mechanism whereby the display members are brought together to present a continuous surface.

BURGLAR-ALARM.—W. G. TILLMAN, New York, N. Y. This alarm is more especially designed for use in connection with doors, so that when the door is opened by a burglar or other unauthorized person, then the alarm mechanism is actuated to sound a bell, and when the door is returned to closed position the sounding of the bell is temporarily continued.

WIRE-NETTING-WEAVING MACHINE.—C. E. BEGG, Mosman, Sydney, New South Wales, Australia. In the present patent the invention has reference to certain improvements in wire-netting-weaving machines and its purpose is to dispense with the tube cases and the connections at present used and consequently with the necessity for the special coiling.

JOINTED FIGURE.—G. W. FERGUSON, Plymouth, Wis. This figure may be of wood or other material, and the construction adapts it to receive many adjustments of its head and all other members, thus rendering the mechanical simulation of a human animal, fowl, or reptile figure, grotesque and very amusing.

TYPE-WRITING MACHINE.—W. C. PAUL, New York, N. Y. The purpose here is to provide an improvement particularly of the wheel class of machines, or class wherein a wheel is mounted to turn upon a spindle, and to provide means for automatically operating a type wheel to the various printing positions corresponding to the keys depressed, and for automatically locking the wheel in position during the operation of printing.

CENTRIFUGAL MACHINE.—E. ROBERTS and A. H. GIBSON, Lehi, Utah. To empty the sugar, the machine is slowed up somewhat, and the hollow shaft being elevated, the bracket is swung so that the horizontal portion thereof projects over the casing. The hand wheel is now turned to lower the hollow shaft through an opening in the top of the casing, after which the lever is turned to bring the paddle into position. After the sugar is loosened, the lever is operated to swing the paddle into position and the hand wheel is rotated to elevate the paddle from the casing, after which the side of the bracket may be swung to the side of the casing out of the way.

COPY-HOLDER.—B. F. PEETZ, Moro, Ore. The main object in this patent is to provide a holder which will bring the lines of the copy into view of the operator consecutively as the platen is rotated for line spacing. A further object is to provide means for operating the holder so that it will feed the copy faster or slower and in such a manner as to be entirely independent of the rotation of the platen.

Prime Movers and Their Accessories.

INTERNAL-COMBUSTION ENGINE.—P. DANIEL, New York, N. Y. In the present patent the invention relates to certain improvements in two-cycle internal combustion engines, and relates more particularly to the means employed for supplying the fuel to form the explosive mixture, and for automatically controlling the amount of fuel admitted.

OIL-PROOF SPARK-PLUG.—E. J. BUSHEY, New York, N. Y. The improvement relates to internal combustion engines, and its object is to provide a spark plug, arranged to prevent oil or the like splashed up against the plug from passing into the spark gap or into the interior of the plug, thus protecting the cap against deleterious influences of the oil and keeping the plug at all times in effective condition.

ROTARY INTERNAL-COMBUSTION ENGINE.—J. S. STEWART, Diamondville, Wyo. In this instance the intention of the inventor is to provide an improved rotary internal combustion engine, which is simple and durable in construction, composed of comparatively few parts, and not likely to get out of order, and arranged to utilize the motive agent to the fullest advantage.

Railways and Their Accessories.

RAIL-FASTENER.—D. ASHWORTH, Wappingers Falls, N. Y. This improvement refers to fasteners for securing railroad rails upon cross ties, and relates more particularly to a device comprising a chair adapted to carry a rail and to rest upon a tie, a holding member extending from the chair to the under part of the tie, and means for securing the member at the under part of the tie.

Pertaining to Vehicles.

VEHICLE-BRAKE.—V. T. SWEENEY, Anchorage, Ky. An object here is to provide a brake having means to manually operate the brake and control the same and also to provide means connected with the brake, whereby the same may be automatically operated by the action of the team attached to the vehicle, in backing, the manually-controlled means and the automatic means being independently operative to apply or release the brake.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.

NEW BOOKS, ETC.

ORNAMENTAL CONCRETE WITHOUT MOLDS. By A. A. Houghton. New York: Norman W. Henley Publishing Company, 1910. 16mo.; 132 pp. Price, $2.

This book treats of the forming of concrete objects in cement by the means of templates. This method is not new, as it involves practically the same methods as used for years in running plaster moldings, center pieces, etc. It has also been explained in detail, in "Concrete Pottery and Garden Furniture," by Ralph C. Davison, published by Munn & Co. The use of templates in concrete work is good for certain classes of work, but the field is limited, inasmuch as plain surfaces only can be produced; that is, no bas-relief work can be reproduced, such as is possible with either glue or plaster molds. This work contains 124 pages, including 30 full-page line drawings, and 20 chapters, many of which are only from one to three pages in length. Several of these chapters are superfluous, inasmuch as they only repeat dimensions which are clearly shown in the illustrations. The larger portion of the work treats of the various architectural orders rather than of how to produce concrete ornaments. If as much space was devoted to the proper ingredients to use in the concrete mixture, and the proper proportions to use in same, as well as to the all-important question of curing the casts—points which have not been touched on at all—the work would be of more practical use to those for whom, the author states, it is intended, as there are very few who understand the great importance of the proper mixtures to use, or the time and methods to be used for producing a perfectly cured cast. The proofreading could be improved on, also the index is not above reproach, as for example the reference to Crazing, page 23. The circular states: "The process of making ornamental concrete without molds has long been a secret and is now given for the first time in this practical book." This statement is misleading and not warranted by the facts. There is no secret about this process.

MODERN PAINTER'S CYCLOPEDIA. By F. Maire. Chicago: Frederick J. Drake & Co., 1910. 16mo.; 465 pp.

Among the subjects treated are: Adulteration of Paint; Blistering of Paint; Brushes; Calcimining; Carriage Painting; China Painting; Colors; Color Harmony; Color Mixing; Color Testing; Exterior Painting; Frescoing; Gilding; Graining; House Painting; Marbling; Oils and Driers; Oil Painting on Glass; Painting a Bath Tub; Painting in Distemper; Paperhanger's Tools; Paper-hanging; Pigments; Scenic Painting; Sign Painting; Stains; Staining; Stenciling; Statuary Painting; Turpentine; Varnishes; Varnishing; Water Color Painting, etc.

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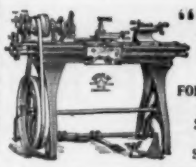
Tantalum, producing, J. Schilling	958,180
Telegraphy, portable station for wireless, G. von Arco	958,209
Telegraphy, receiver for wireless, W. Schloemilch	958,181
Telephone meter system and apparatus, R. H. Manson	958,145
Telephone repeater, P. Stragiotti	958,560
Telephone system, L. E. Hicks	958,248
Telephone system, E. C. Rodman	958,315
Telephone system, C. L. Goodrum	958,627



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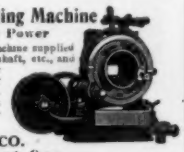

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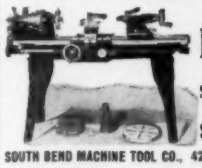

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This issue contains a large number of other articles on divers subjects, all of interest to the practical man or woman who is interested in country life in its broadest sense.

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Any one desiring to order the full equipment described in the text of the article can do so by addressing the Editor of *American Homes and Gardens*, at the above address. No expense or commission is charged for attending to such orders.

The Latest Giant Freight Engine.

(*Concluded from page 436.*)

miles. On these divisions there is a heavy movement of freight traffic, consisting mostly of loaded coal trains. The grade conditions on this portion of the road are severe and sharp; curves are numerous. Against northbound traffic, in which direction practically all the movement of loaded freight trains takes place, there is a six-mile grade of 1.36 per cent from Carbondale to Forest City. From the latter point to Ararat, the summit of the rise, a distance of 14 miles, the road is on a grade averaging 0.31 per cent. Going down the other side of the mountain, it is practically a continuous grade of 51.7 feet per mile for 75 miles into Oneonta.

Hitherto the freight traffic on this division has been handled by consolidation locomotives, having a theoretical maximum tractive power of 49,690 pounds. A single engine of this class can very satisfactorily handle a 2,600-ton train from Ararat to Oneonta; but it requires the assistance of two locomotives of the same class, as pushers, to haul this load up the 20-mile grade to Ararat, at which point the pushers cut loose.

With a view to reducing the operating expenses of the division and facilitating the movement of trains, the officials of the Delaware & Hudson Company decided to investigate the efficiency of the Mallet type locomotives for this service. It was their aim to secure a pusher engine of this type of sufficient power to move the maximum train load up the hill with two engines instead of three.

In the fall of last year one of the heavy Mallet engines built by the American Locomotive Company for the Erie Railroad was borrowed, and put into pusher service on the 20-mile Ararat grade. A number of test runs were made, which proved that a single Erie Mallet engine easily did the work of two of their Class E-5 consolidation locomotives. Following these tests the six Mallet engines were ordered from the American Locomotive Company, and put into this service.

These engines are of a straightforward design, embodying but slight modifications from the designs of previous locomotives of this type of lesser weight and power constructed by these builders. With the boiler pressure of 220 pounds and driving wheels 51 inches in diameter, the theoretical maximum tractive power, working compound, calculated by the company's formula, is 105,000 pounds.

As this formula, which is applicable only to articulated locomotives built by this company, is based on the results obtained from a large number of indicator cars, taken under various service conditions, it is found that the tractive power thus calculated represents very accurately the actual power that the locomotive can develop at a piston speed of not over 250 feet per minute.

With the company's system of compounding, the normal maximum tractive power, working compound, can be increased about 20 per cent by changing the engine into simple. The maximum tractive power of these engines working simple is thus 126,000 pounds.

New Two-Cycle Motors.

(*Continued from page 444.*)

compressed air which would then be furnished by chamber *B* to receiver *D*. It is well understood that the high velocity produced by air under pressure is far more efficient in atomizing liquids than the comparatively low velocity produced by suction. This type of engine should produce twice the power of a four-cycle engine of the same size and speed, and we are informed that tests now being made show this to be the case.

Another engine using a differential piston, but in an entirely different way, is the Shortt Motor. This engine compresses air only in the crank case. Unlike the others here described, it does not admit this air through a port opened

(*Concluded on page 450.*)

Classified Advertisements

Advertising in this column is 75 cents a line. No less than four nor more than 10 lines accepted. Count seven words to the line. All orders must be accompanied by a remittance. Further information sent on request.

READ THIS COLUMN CAREFULLY.—You will find inquiries for certain classes of articles numbered in consecutive order. If you manufacture these goods write us at once and we will send you the name and address of the party desiring the information. There is no charge for this service. **In every case it is necessary to give the number of the inquiry.** Where manufacturers do not respond promptly the inquiry may be repeated.

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Inquiry No. 8918.—For manufacturers of "Wydt's Electro-Catalytic Sparking Plug."

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Inquiry No. 8987.—Wanted, the manufacturers of the Van Winkle Woods & Sons, and the Weber power meters.

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PATENT No. 935,870. An improved vehicle wheel, intended for automobile, or to take the place of pneumatic tires. John H. Scott, 69 Prince St., New York City.

Inquiry No. 9029.—Wanted, catalogues and all information on machinery for braiding straw in manufacturing straw hats.

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Inquiry No. 9038.—Wanted, the address of the Chipman Electric Purifying Co.

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MISCELLANEOUS.

STAR.—Sphere of Light—Clock. For particulars address William Rose.

Inquiry No. 9078.—Wanted, the address of manufacturers of sewer pipe, made of fiber and asphaltum, suitable for laboratory use.

Inquiry No. 9080.—Wanted the address of parties manufacturing paste-making machinery.

Inquiry No. 9083.—Wanted, the address of firms manufacturing small beer brewing plants, from 75 to 100 gallons a day.

Inquiry No. 9092.—Wanted, the address of some firms who manufacture permanent lamp wicks.

Inquiry No. 9094.—Wanted address of The Thomas Arithometer Company, also Burkhart Arithmometer Company.

Inquiry No. 9096.—Wanted, the address of manufacturers of spiral welded pipes, possessing great strength.

Inquiry No. 9097.—Wanted, address of makers of impulse water wheels.

Inquiry No. 9098.—Wanted, name and address of the manufacturers of the ozonizer.

Inquiry No. 9099.—Wanted, address of manufacturers of machinery for making wire cables.

Inquiry No. 9101.—Wanted, addresses of manufacturers of a dip or magnetic needle, for exploring for iron ore.

Inquiry No. 9107.—Wanted, addresses of manufacturers of small emery files (pieces of emery in the shape of a file).

Inquiry No. 9109.—Wanted addresses of the manufacturers of the Dion Desk Clock.

Inquiry No. 9113.—Wanted name and address of the manufacturers of the Russell Patent Automatic Ink Well.

Inquiry No. 9114.—Wanted name and address of manufacturer of the Auto Lantern Globe. Fits all lanterns.

Inquiry No. 9115.—Wanted a machine for making pen nibs, similar to Wm. Mitchell's G & J. nibs and Waverly nibs.

Inquiry No. 9117.—Wanted names and addresses of the manufacturers of pedometers.

Inquiry No. 9118.—Wanted, a muffler for a gasoline engine, built upon the principle of the Maxim silencer, recently brought out for use on rifles.

Inquiry No. 9119.—Wanted, name and address of the manufacturer of Zeglin bullet-proof cloth.

Inquiry No. 9120.—Wanted, the address of the Ideal Fuel Feeder Co.

Inquiry No. 9121.—Wanted, manufacturers of cut stencils for fancy work, sofa pillows, etc., and oil colors and brushes for same.

Inquiry No. 9124.—Wanted, name and address of a company in Germany making a machine to manufacture a cement and asbestos shingle and building lumber.

Inquiry No. 9127.—Wanted, address of L. Dermigny, manufacturer of a family ice machine for $10.00

Inquiry No. 9132.—Wanted, manufacturers of a gasoline traction engine with a hoisting attachment; in other words, the machine will be used as a portable stump puller to pull sassafras roots, used in making oil of sassafras.

Inquiry No. 9134.—Wanted, a small hydraulic motor, capable of giving about one horse power, with a water power of 35 lbs. per square inch.

Inquiry No. 9135.—Wanted, name and address of manufacturers of the Parshall Compressed Air Ice Machine.

Inquiry No. 9136.—Wanted, the name and address of a skunk raising farm.

Inquiry No. 9137.—Wanted, a device that will braid leather strips for horse whips.

Inquiry No. 9138.—Wanted, the address of manufacturers of machines capable of forming a number (12 or more) of pieces of paste about 36 mm. x 32 mm x 6 mm., made of lead oxide and sulphuric acid, and placing them into a frame having a separate compartment for each piece, the space between each piece and the next being all round 4 mm. The process could be somewhat similar to biscuit making.

Inquiry No. 9139.—Wanted, the name and address of some manufacturer of a coffee mill run by water motor.

Inquiry No. 9140.—Wanted, manufacturers of disc records for gramaphones that use a sapphire point instead of a steel needle.

Inquiry No. 9143.—Wanted, name and address of the manufacturers of an air mattress.

Inquiry No. 9144.—Wanted, manufacturers of machinery for making soda water tubes, commonly known as straws.

Inquiry No. 9145.—Wanted, to buy machinery to load blasting caps or detonators.

Inquiry No. 9149.—Wanted, manufacturers of machinery for roasting coffee for small and large industries.

Inquiry No. 9150.—Wanted, manufacturers of machinery for the manufacture of French heels for ladies' shoes.

Inquiry No. 9152.—Wanted, the address of the Graham Safety Lamp Filler and Ventilator.

Inquiry No. 9153.—Wanted, name and address of manufacturers of a knotless clothes line.

Inquiry No 9154.—Wanted, name and manufacturers of a newspaper vending machine.

Inquiry No. 9155.—Wanted, the address of manufacturers of an electric milking machine.

Inquiry No. 9156.—Wanted, the name and address of manufacturers of a rust proof oil, known as Cachouc Oil.

Inquiry No. 9157.—Wanted, manufacturers of peanut shelling and cleaning machinery.

Inquiry No. 9158.—Wanted, manufacturers of a material in sheets to take the place of vulcanized fibre for novelty work.

Inquiry No. 9159.—Wanted, manufacturers of any successful substitute for hard rubber.

Inquiry No. 9161.—Wanted, a machine that will grind oranges, pulp and skin into a smooth liquid or cream.

Inquiry No. 9162.—Wanted, addresses of shirt makers in Manhattan, who will make a few shirts of special design.

Inquiry No. 9163.—Wanted, manufacturers of a cradle worked by clock work.

(Concluded from page 449.)

by the piston, but uses instead a valve which is vacuum actuated. The partial vacuum to operate this valve is formed above the larger differential piston *F*. When this piston reaches the bottom of its stroke it uncovers a port *G*, through which air enters and breaks the vacuum, whereupon the valve instantly closes. The fuel is fed from a pressure tank through a needle valve, and is delivered at the seat of the main inlet valve. As the pressure in this tank is greater than that of the inrushing air from the crankcase, it forces the fuel into the cylinder against the air pressure. It is claimed that the time the valve is open will vary with the speed of the engine so as to let in the right amount of fuel. The annular chamber of the piston is used only to produce a partial vacuum which operates the main valve. This engine should get sufficient air for clearing the cylinder on account of the enlarged piston end and should be able to produce considerably more power than the usual two-cycle motor.

Prof. S. P. Thomas recently stated before the Royal Society that he had succeeded in producing a physiological effect by means of magnetism. A coil of copper wire was made 9 inches in diameter and 8 inches long, containing 32 turns. Through this an alternating current of 50 cycles was passed, with a maximum flow of 180 amperes, giving 5,760 ampere turns. In a dark room, when an observer placed his head in the mouth of the coil, he could see a faint bluish light, which was not steady but appeared to flicker considerably. This could be observed

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About a year ago it was decided to open a department in the Scientific American devoted to the interests of the handy man. There was an almost immediate response. Hundreds of valuable suggestions poured in from every part of this country and from abroad as well. Not only amateur mechanics, but professional men as well were eager to recount their experiences in emergencies and offer useful bits of information, ingenious ideas, wrinkles or "kinks," as they are called. Aside from these, many valuable contributions came from men in other walks of life—resourceful men, who showed their aptness at doing things about the house, in the garden, on the farm. The electrician and the man in the physics and chemical laboratory furnished another tributary to the flood of ideas. Automobiles, motor cycles, motor boats and the like frequently call for a display of ingenuity among a class of men who otherwise would never touch a tool. These also contributed a large share of suggestions that poured in upon us. It was apparent from the outset that the Handy Man's Workshop Department in the Scientific American would be utterly inadequate for so large a volume of material; but rather than reject any really useful ideas for lack of space, we have collected the worthier suggestions, which we present in the present volume. They have all been classified and arranged in eight chapters, under the following headings:

Handy Man's Electrical Laboratory; VII. The Handy Man About the House; VIII. The Handy Sportsman; IX. Model Toy Flying Machines. Index.

I. Fitting up a Workshop; II. Shop Kinks; III. Soldering of Metals; IV. The Handy Man in the Factory; V. The Handy Man's Experimental Laboratory; VI. The

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even with the eyes closed. When the experiment was tried in broad daylight with the eyes open, this flickering sensation still persisted. The blue light, which was visible only in the dark, appeared to be brighter near the wire than in the center.

How to Act in Case of Fire.

(*Concluded from page 441.*)

dredging the part thickly with flour—if the skin is not broken—and not disturbing it for some time.

Any vegetable oil—such as salad, sweet, or linseed—may be used with advantage, a rag being soaked with it and used to cover the wound. A very good application is made by mixing equal parts of linseed oil and lime water, forming "carron oil."

Finally, it cannot be too strongly impressed that all clothing covering a burn must be removed with the utmost care. Never try to withdraw the injured limb, but cut the clothing away—in small pieces, if necessary—so that the injured surface may not be more damaged. Never hold a burn in front of the fire, according to the popular practice; this only increases the injury. Have your oil or other application ready for immediate use as soon as the clothing has been removed.

Fontenelle's Theory of Comets.

The idea of comparing comets to great glass lenses, which concentrate the sun's rays into luminous cones which appear as the comets' tails, is so natural that its origin cannot be traced. It was indicated by the philosopher Seneca, about the commencement of the Christian era, but it has been abandoned in accordance with the example of Kepler, who after first embracing this doctrine with enthusiasm, renounced it on discovering that a large comet, which he had occasion to observe, possessed a curved tail. The impossibility of explaining this phenomenon, at a time when it was not known that light consumes a measurable time in traversing interplanetary space, caused Kepler to abandon the idea. The celebrated Fontenelle, regardless of this objection, took up and expounded the lenticular theory of comets in an admirable manner in his "Plurality of Worlds." The coming of Halley's and several other comets has caused Wilfrid de Fonvielle to recall the attention of the French Academy to Fontenelle's theory and the arguments which may be brought forward in its favor. At present, on the coast of every civilized country, phenomena similar to those to which Fontenelle attributed the formation of the tails of comets, are produced by the lanterns of lighthouses. The dust which is suspended in the atmosphere is illuminated by the beam of light, as Fontenelle supposed the cosmical dust to be illuminated by the concentrated beam of sunlight behind the lenticular comet. De Fonvielle shows that this theory explains the individual peculiarities of comets, and is confirmed by observations made recently at the Paris and Greenwich observatories. For example, a division of the tail is explained by assuming that the cloud of cosmical dust is not continuous, but intermittent, and the occasional sudden appearance of bright points indicates the existence of a reflecting body of considerable size. In a word, all the variations which are observed in meteoric showers might on this theory be expected to occur in the tails of comets. The evidence of the spectroscope and the freaks of Morehouse's and Halley's comets are against this lenticular theory.

Engineers of the United States Geological Survey estimate the annual damage by floods in the United States at $100,000,000. It is too early, perhaps, to undertake to prevent or to diminish this immense loss, but its very magnitude invites a serious study of means of prevention, and the recent misfortune of France may lead to practical work that will serve as an object lesson to America.

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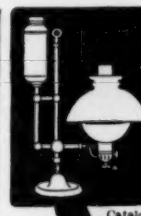

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Scientific American No. 6, Vol. XCIX. **The Mystery of Comets.** An article in which the famous comets of the last century are enumerated and described and modern cometary theories discussed.

Scientific American Supplement No. 1728. **Ancient and Popular Ideas About Comets.** Queer superstitions about the strangest of heavenly bodies.

Scientific American No. 7, Vol. CI. **Halley's Comet.** An interesting article by Dr. Alexander W. Roberts, in which the general history of Halley's famous comet is sketched with comments on its past appearances.

Scientific American Supplement No. 1705. **The Next Apparition (1910) of Halley's Comet.** An important article by H. C. Wilson, with a map giving the position of the comet relatively to the orbits of the planets from September 15, 1908, to July 13, 1910.

Scientific American Supplement No. 1632. **Halley's Comet.** An article by F. W. Henkel, F.R.A.S., which tells how Halley came to discover the comet which bears his name, and how mathematicians have plotted its orbit.

Scientific American Supplement No. 1770. **Edmund Halley.** A biography by J. E. Gore, M.R.I.A., of the man who dispelled cometary superstitions and popularized the law of gravitation.

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Scientific American Supplement No. 1785. **Halley's Comet as Seen from the Earth.** A table prepared by the distinguished Greenwich astronomer, P. H. Cowell, giving the ecliptic co-ordinates of Halley's comet to two decimal places at intervals of four days through an arc extending from one end to the other of the latus rectum of its orbit. The figures apply approximately to any return.

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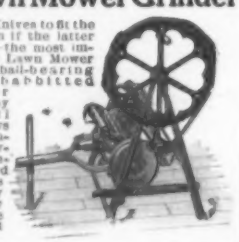

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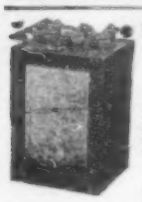

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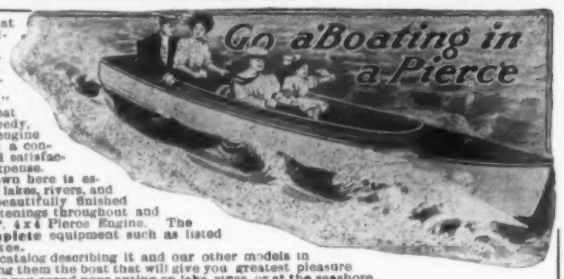

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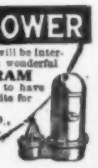

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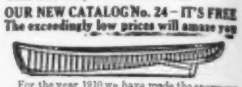

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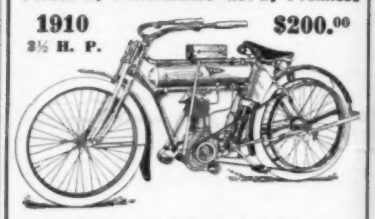

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